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Parasitological, epidemiological, and hematological findings in Spix's yellow-toothed cavy (*Galea spixii* Wangler, 1831) in the State of Paraiba, northeastern Brazil

Achados parasitológicos, hematológicos e epidemiológicos em preás- (*Galea spixii* Wangler, 1831) do Estado da Paraíba, nordeste do Brasil

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Highlights

First report of *Gyropus ovalis, Laelaps* sp. and *Chirodiscoides cavia* in *Galea spixii.*
PCR for hemotropic *Mycoplasma* sp., *Babesia* sp., *Ehrlichia* sp., and *Bartonella* sp.
The hematological profile of Spix's yellow-toothed cavy was determined.

Abstract

Brazil is composed of large ecosystems with vast biodiversity in fauna and flora. Agriculture and livestock farming provides an interaction between humans and domestic and wild animals, which favors the dissemination of infectious and parasitic agents. Wild rodents present a wide ecological diversity; therefore, it is necessary to know which species may be carriers of pathogens. This study aims to identify endo and ectoparasites, and hemoparasites in Spix's yellow-toothed cavy (*Galea spixii* Wangler, 1831), and determine the hematological parameters of this species. The study was carried out with 16 adult specimens from both sexes, captured in the rural areas of Remigio and Areia, Paraiba State, northeastern Brazil. All Spix's yellow-toothed cavies presented ectoparasites, *Gliricola quadrisetosa, Gyropus ovalis, Laelaps* sp. and *Chirodiscoides caviae,* and endoparasites identified by the presence of Nematode eggs,

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Cestode eggs, and coccidian oocysts in the stool samples. To the best of our knowledge, this is the first report of parasitism by *Gyropus ovalis, Laelaps* sp. and *Chirodiscoides cavia* in Spix's yellow-toothed cavy. Animals tested negative by PCR for hemotropic *Mycoplasma* sp., *Babesia* sp., *Ehrlichia* sp., and *Bartonella* sp. For the first time, the hematological profile of these animals was determined. These results can be the basis for future research with the species, which can be used as a sample animal in experiments in clinical settings as an epidemiological guide since this species is routinely used by impoverished populations in the Northeastern region of Brazil as pets, as well as a source of protein.
Key words: Ectoparasites. Endoparasites. Hemoparasites. Cavy. Rodent.

Resumo

O Brasil é composto por grandes ecossistemas com vasta biodiversidade na fauna e flora. O desenvolvimento da agricultura e pecuária proporciona uma interação entre a população humana e animais domésticos e silvestres, o que facilita a disseminação de agentes infecciosos e parasitos. Os roedores selvagens apresentam uma ampla diversidade ecológica; portanto, é necessário conhecer as espécies que podem ser portadoras de patógenos. O presente estudo tem como objetivo identificar endo e ectoparasitos, e hemoparasitos em preás (*Galea spixii* Wangler, 1831), e determinar os parâmetros hematológicos desta espécie. O trabalho foi realizado com 16 espécimes adultos de ambos os sexos capturados nas áreas rurais de Remígio e Areia, estado da Paraíba, nordeste do Brasil. Todos os animais apresentaram ectoparasitas, *Gliricola quadrisetosa, Gyropus ovalis, Laelaps* sp. e *Chirodiscoides caviae,* e endoparasitos identificados pela presença de ovos de nematódeos, ovos de cestódeos e oocistos de coccídeos na amostra de fezes. Este é o primeiro relato de parasitismo de *Gyropus ovalis, Laelaps* sp. e *Chirodiscoides cavia* em preás. Os animais testaram negativo na PCR para *Mycoplasma* sp., *Babesia* sp., *Ehrlichia* sp., e *Bartonella* sp. Pela primeira vez, foi determinado o perfil hematológico desses animais. Esses resultados podem servir de base para futuras pesquisas com a espécie, que pode ser utilizada para experimentação em ensaios clínicos como guia epidemiológico, uma vez que essa espécie é rotineiramente utilizada por populações empobrecidas da região Nordeste do Brasil como fonte proteica, além de seu uso como animais de estimação.
Palavras-chave: Ectoparasitos. Endoparasites. Hemoparasitos. Preá. Roedor.

Introduction

The Rodentia order comprises more than two hundred thousand species, making it the most numerous in placental mammals. The cavies of the *Galea* genus are from the Caviidae family, and Caviinae subfamily, and are represented in Brazil by *Galea flavidens* and *Galea spixii* (Bonvicino et al., 2008). In South America, Spix's yellow-toothed cavies (*Galea spixii*) are one of the main species of rodents and, when properly bred, may be used mainly as a source of income, with the commercial interest of its products such as meat and leather (Santos, 2018). In Northeastern Brazil, they are consumed as a source of animal protein by rural populations, especially in periods of lack of rain; they can be found in rural areas (Barboza et al., 2016).

The breeding of these animals in captivity is common for populations in tropical and subtropical regions (Von Richer,

1976; Alves, 2012). In the Brazilian semi-arid region, besides their use for food, cavies have artisanal and zootherapeutic uses, and are even used as pets and in scientific research (Alves, 2012). However, the invasion of ecosystems, and the agricultural development, led to a closer contact between human, domestic, and wild animal populations, favoring the spread of infectious and parasitic agents (Engering et al., 2013) mainly in human beings. In that context, to better understand the natural cases, the epidemiological study of zoonosis is indispensable, defining the risk factors in particular ecosystems, the flow of the agents in wild animals, and the local, regional, and national importance of the diseases, in order to subsidize public health activities and veterinary services (A. D. Barbosa et al., 2011). Therefore, the present study aims to identify hemoparasites, endo, and ectoparasites in free-living Spix's yellow-toothed cavies, and determine the hematological parameters of this species.

Materials and Methods

Animals

Sixteen animals of the *Galea spixii* species were captured in December 2017 in the rural areas of Areia and Remígio, under the authorization of the Authorization System and Biodiversity Information - SISBIO, number 59208-1, and certified by the Ethical Commission in the use of animals (CEUA) number: 149/2017. These cities are located in the Immediate Geographical Region of Campina Grande, the climate is mild, and the average year temperature is 22°C (M. R. D. V. Barbosa et al., 2004). This region is composed of mountain forests, considered an ecological disjunction of the Atlantic forest, separated by the *Caatinga* (arid) vegetation. This condition makes them reminiscent of high diversity areas. Cage-type traps with baits (Tomahawk) were utilized. The species were identified and classified based on specialized literature described in the Guide to Brazilian Rodents, with gender keys based on external characters (Bonvicino et al., 2008). After they were captured, the animals were sent to the Federal University of Paraiba, Agro Sciences Center, Areia, Paraiba, Brazil, to collect the research material on the same day of capture. The cavies were distributed in cages and separated according to weight and size, avoiding overcrowding, providing them with wellbeing and comfort, always trying to minimize their stress. Food was continuously provided, and they were kept under natural light conditions until time for the collection of material and posterior euthanasia.

Chemical restrain and Euthanasia

Xylazine 10% and ketamine 5% on a 3mg/kg dosage and 15mg/kg respectively were used to chemically restrain the animals. An intramuscular injection on the back part of their thighs was applied. After sedating, the specimen was taken from the cage and weighed on a precision scale (Pereira et al., 2013). Weight, size, and sex were evaluated. For euthanasia, an overdose of dissociative anesthetic association was given after general anesthesia, and then exsanguination by cardiac puncture for confirmation, a method recommended by the National Control Board of Animal Experimenting - Concea.

Ectoparasites collection: Grooming

The animals were submitted to manual grooming for a more precise collection. Utilizing Swabbing was utilized to collect the parasites, which helped to preserve and transfer them to a glass blade. The ectoparasites found were bleached with 10% potassium hydroxide for approximately 1 hour, and then were analyzed under light microscopy and identified (Ewing, 1924; Serra-Freire & Mello, 2006; Werneck, 1942) on an OLYMPUS BX53F™ (Tokyo, Japan) microscope coupled with a digital (OLYMPUS DP73™) camera, by using Image cellSens DimensionTM software.

Skin scraping

Scraping was done on the posterior part of their back and the inferior jaw part, using scalpel blades to help in the process. The collected material was transferred to a glass blade with a 10% potassium hydroxide solution for approximately 1 hour for bleaching (Pereira et al., 2013). After that period, the material was analyzed under light microscope OLYMPUS BX53F™ (Tokyo, Japan).

Ear swabbing

Ear wax collection was performed individually with swabs in the pinna. The material was transferred to a glass blade, bleached with a 10% potassium hydroxide solution for approximately 1 hour, and was analyzed under light OLYMPUS BX53F™ (Tokyo, Japan) microscope.

Endoparasites collection: Fill Flotac and Mini Flotac

Fill-FLOTAC is a disposable sampling device that is part of the FLOTAC and mini-FLOTAC kits (Cringoli et al., 2013). They are made by recipients, one collector, and one filter. These kits facilitate the procedures of the four consecutive stages of the mini-FLOTAC techniques, which are: collection (including weight measurement), homogenization, filtration, and filling. The mini-FLOTAC is very useful for multivalent techniques that allow the simultaneous diagnosis of eggs, larvae, oocysts, and cysts (Maurelli et al., 2014). The stool samples were collected fresh and immediately analyzed (2 g from each individual fecal sample). For every gram of stool, 9ml of saturated solution was used for dilution, and the process was performed as described by Maurelli et al. (2014). Magnifications of 100x and 400x were used to identify helminthic eggs and protozoan cysts/oocysts. The results were expressed as the arithmetic average number of eggs/oocysts per gram (EPG/OPG) of feces.

By counting eggs or oocysts in the samples, the infection was classified according to endoparasite: The nematode infection was classified as: light (< 100 epg), moderate (100 to 400 epg), using the average of 200 epg for this category, and intense (> 400epg), according to Queiroz et al. (2016); the cestodes infection degree was zero (in animals without this parasite's eggs) and light (< 20 epg), and the protozoan infection was classified as: light (< 2.500 opg), moderate (2.500 to 5.000 opg), using the average of 3.750 opg for this category, and intense (> 5.000 opg), following the instructions of Moraillon et al. (2013).

Hemoparasites collection

The parasitic research was performed by analyzing blood smears after the antisepsis of the pinna with iodinated alcohol. The skin was perforated with a sterilized needle, and the blood drop was put on the glass blade for the blood smear. After drying, the blades were stained with Panotic, and analyzed under light microscopy to search for protozoan structures.

Blood samples

Blood samples from young and adult clinically healthy Spix's yellow-toothed cavies were collected. After chemically restrained, the animals were laid on a flat surface, and the blood samples (up to 2 mL) were taken by intracardiac puncture, placed into tubes containing EDTA (BD Vacutainer®) for hematological analysis, and kept at −20°C until testing by PCR.

Blood count

All animals were submitted to a physical exam, and samples were collected from eight animals that presented good health signs at the clinical exam. The average values were calculated and their respective deviation from the standards to the following hematological pattern: red blood cell count, hemoglobin, packed cell volume (PCV), MCV (Mean Corpuscular Haemoglobin), total plasma proteins, MCHC (Mean Corpuscular Haemoglobin Concentration), fibrinogen, platelets, total leukometry, neutrophils, eosinophils, basophils, lymphocytes, and monocytes.

Packed Cell Volume (PCV) was determined by the microhematocrit method. The hematimetry (Hm) was determined by counting in Neubauer chamber, in a diluted physiological solution of NaCl 0.9% (1:200). To determine the hemoglobin's concentration (Hb), the modified cyanometa hemoglobin method was used. The average globular volume (VGM) and the concentration of average globular hemoglobin (CHGM) were obtained through mathematic calculations. The global leukocytes count was determined by counting in a Neubauer chamber in a diluting solution with Turk liquid (1:20). The differential leukocytes count was performed, counting 100 leukocytes in blood smear. The platelets were determined by indirect counting of the blood smear. And the total plasmatic proteins (PPT) and the fibrinogen were determined by refractometry in the heat precipitation technique.

DNA extraction and PCR assays

DNA was extracted from 200 µL of blood using a commercially available kit (GE Healthcare, Illustra™, Blood GenomicPrep Min Spin Kit, Buckinghamshire, UK), following the manufacturer's instructions. Ultrapure water was used as a negative control in parallel to monitor for cross-contamination.

A PCR for the mammal endogenous gene glyceraldehyde 3-fosfate dehydrogenase gene (*gapdh*) was performed to monitor DNA extraction (Rebouças et al., 2013). After that, all DNA samples were screened utilizing a genus-specific PCR assay targeting a fragment (900 bp) of the *16S rRNA* gene of hemoplasmas (R. P. A. Oliveira et al., 2021; Machado et al., 2017).

Additionally, DNA samples were also tested by PCR assays, targeting a fragment (551 bp) of the *18S rRNA* gene of *Theileria/Babesia* spp. (Almeida et al., 2012) and a fragment (349 bp) of *16S rRNA* gene of *Ehrlichia/Anaplasma* spp. (Collere et al., 2021) (Table1). DNA from *Mycoplasma ovis* (Machado et al., 2017), *Babesia vogeli* and *Ehrlichia canis* obtained from naturally infected dogs, and *Bartonella henselae* obtained from a naturally infected cat, and nuclease-free water were used as positive and negative controls, respectively.

Table 1
Sequence of oligonucleotides (primers) selected for the amplification and PCR's parameters analyzed in specimens of wildlife *Galea spixii* from the State of Paraiba, Brazil, compared to other studies

Primes	Specificity	Primers' Sequence	Extended fragment	Thermical Conditions	References
GAPDH-F GAPDH-R	GAPDH	CCT TCA TTG ACC TCA ACT ACA T CCA AAG TTG TCA TGG ATG ACC	400 pb	94 °C for 3 minutes; 30 cycles in 94 °C, 56 °C and 72 °C for 45 second each, respectively; and 72 °C for 5 minutes.	Birkenheuer, 2003
16S HAEMOF 16S HAEMO R	*Mycoplasma* sp.	GGC CCA TAT TCC TRC GGG AAG ACR GGA TTA CTA GTA ATT CCA	950 pb	94 °C for 3 minutes; 35 cycles in 94 °C for 45 seconds, 59 °C for 45 seconds and 72 °C for 1 minute and 30 seconds; 72 °C for 10 minutes	Hoelzle et al., 2011
16S HAEMO F Mt 2 R	*Mycoplasma* sp. *Mycoplasma turicensis*	GGC CCA TAT TCC TRC GGG AAG CGC TCC ATA TTT AAT TCC AA	294 pb	94 °C for 3 minutes; 35 cycles in 94 °C for 30 seconds, 55 °C for 30 seconds and 72 °C for 1 minute; and 72 °C for 10 minutes.	This article
BAB 2 143-167 BAB 2 694-667	*Babesia* sp.	CCG TGC TAA TTG TAG GGC TAA TAC A GCT TGA AAC ACT CTA RTT TTC TCA AAG	551 pb	94 °C for 1 minute; 35 cycles in 94 °C for 30 seconds, 58 °C for 30 seconds and 72 °C for 1 minute; and 72 °C for 10 minutes.	Almeida, 2011
EHR16S F EHR16S R	*Ehrlichia* sp.	GGT ACC YAC AGA AGA AGT CC TAG CAC TCA TCG TTT ACA G	345 pb	94 °C for 3 minutes; 35 cycles in 94 °C for 45 seconds, 55 °C for 30 seconds and 72 °C for 45 seconds; and 72 °C for 5 minutes.	Inokuma, 2011
325s F 1100s R	*Bartonella* sp.	CTT CAG ATG ATG ATC CCA AGC CTT YTG GCG GAA CCG ACG ACC CCC TGC TTG CAA AGC A	600 pb	94 °C for 1 minute; 35 cycles in 94 °C for 30 seconds, 64 °C for 30 seconds and 72 °C for 1 minute; and 72 °C for 1 minute.	Diniz, 2007

Analytical statistics

In the analytical analyses, the average values and deviation from the standards to the following hematological patterns were determined on Microsoft Excel™ program.

Results and Discussion

Ectoparasites

All the wild cavy (*Galea spixii*) presented infestation of the ectoparasites *Gliricola quadrisetosa* (Figure 1), *Gyropus ovalis* (Figure 2), *Laelaps* sp. (Figure 3), and *Chirodiscoides caviae* (Figure 4). Two species of louse from the Gyropidae family were identified: *G. quadrisetosa* and *G. ovalis.*

The mites were identified as belonging to the *Laelaps* sp. genus and *Chirodiscoides caviae* species (Figure 5) (Hirst, 1917; Serra-Freire & Mello, 2006). Results are shown in percentage, and between brackets are the number of animals with a positive result and the total of animals tested, respectively.

Figure 1. Microphotography of female *Gliricola quadrisetosa* found in the wildlife *Galea spixii* in the State of Paraiba, Brazil. Abdominal view (A); posterior region giving emphasis on the genitals (B). Microphotography of male *Gliricola quadrisetosa:* Abdominal view (C); posterior region giving emphasis on the genitals (D).

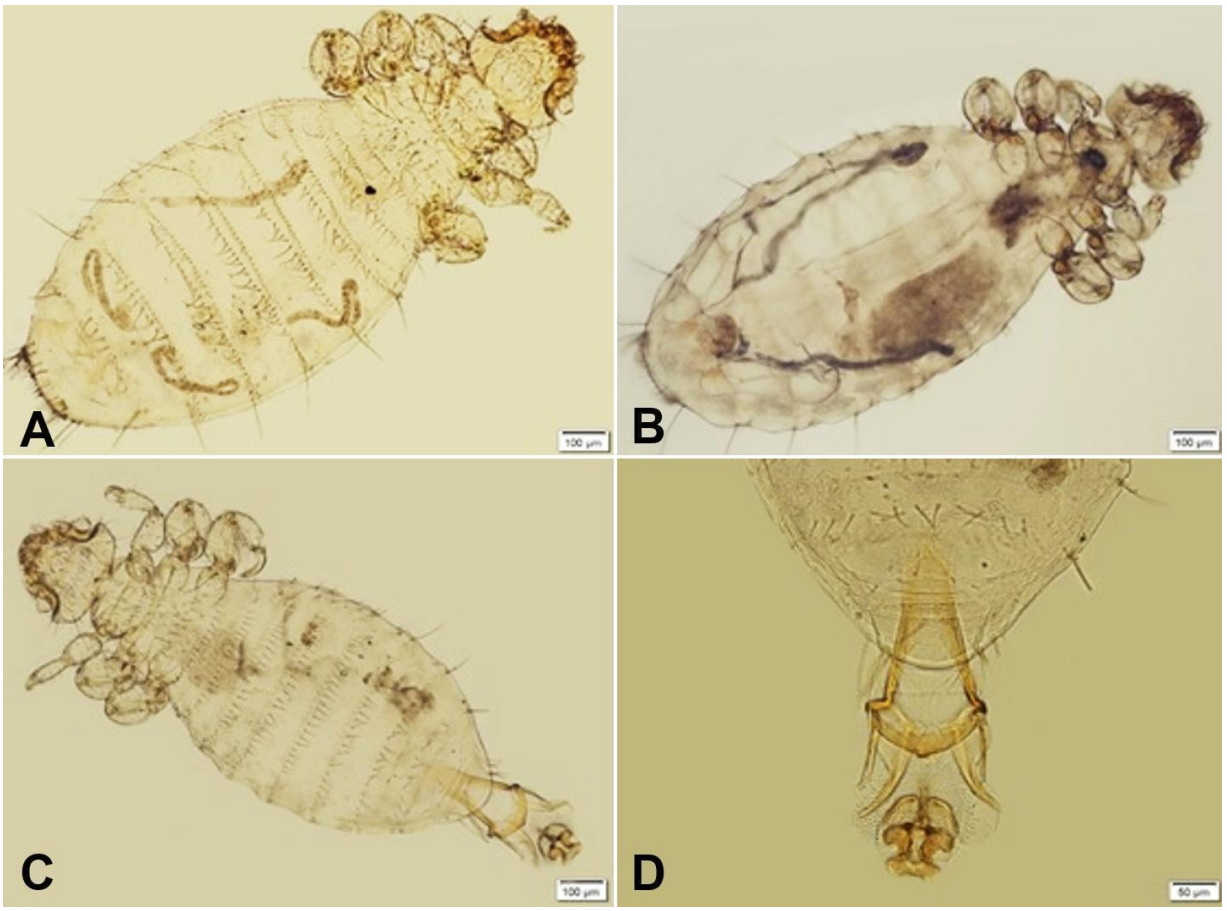

Figure 2. Microphotography of female *Gyropus ovalis* found in the wildlife *Galea spixii* in the State of Paraiba, Brazil. Dorsal view (A); Abdominal view (B). Microphotography of male *Gyropus ovalis:* Abdominal view (C); posterior region giving emphasis on the male's reproductive apparatus (D).

Figure 3. Microphotography of the abdominal view of a male *Laelaps* sp., found in wildlife *Galea spixii* at the State of Paraiba, Brazil.

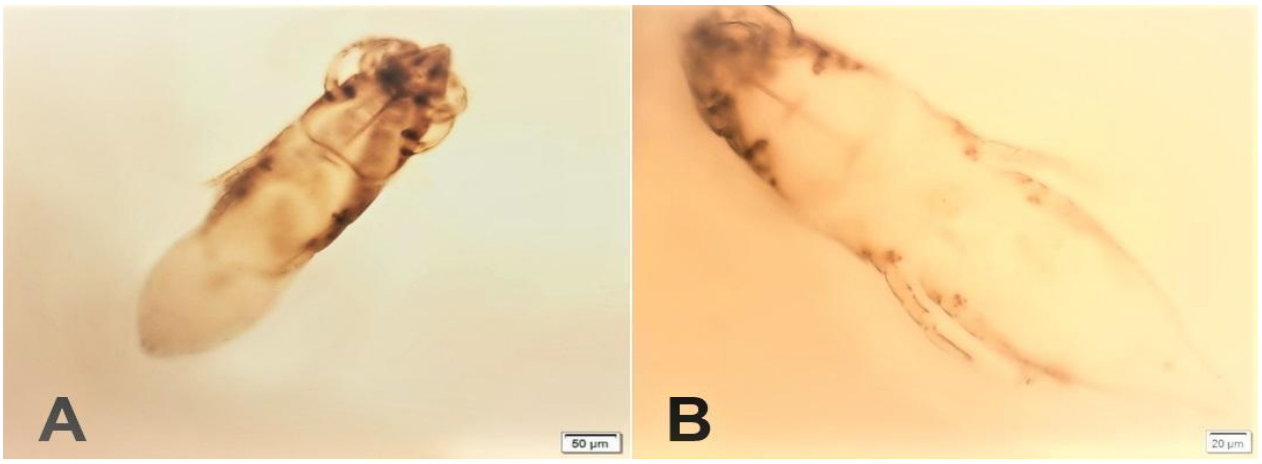

Figure 4. Microphotography of a *Chirodiscoides caviae,* found in wildlife *Galea spixii* at the State of Paraiba, Brazil. Dorsal view. Female (A); Male (B).

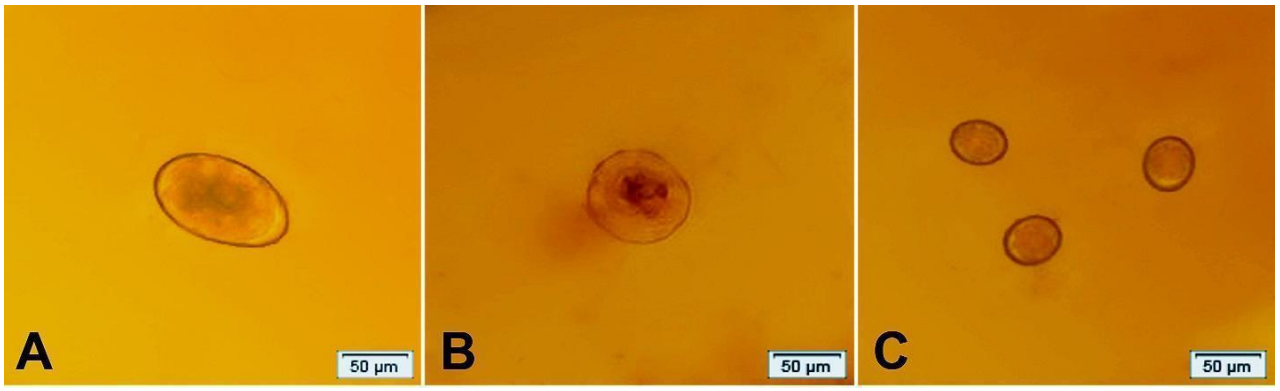

Figure 5. Findings in the stool sample of the wildlife *Galea spixii* from the State of Paraiba, Brazil using the mini-FLOTAC technique. Nematodes' eggs (Strongylida) (A), Cestodes' eggs (B) and oocysts from coccidian (C).

No blood smear presented any visible structures of hemoparasites. The nematode infection was classified as: light (< 100 epg). The feces from the rodents' intestine also contained a small number of coccidians: less than 5.000 oocysts per gram of stool taken directly from the intestine, and some species were not pathogenic or a little pathogenic (*Eimeria coecicola, E. perforans, E. exigua* and *E. vejdovsky*) (Moraillon et al., 2013).

PCR assays

Every sample amplified the GAPDH gene. Thus, a total of 16 samples were analyzed, and in all of them, the results were negative for the primers tested.

Blood count

After the laboratorial analysis the following average values and pattern deviations were obtained to determine the blood parameters of the *G. spixii.* The red blood cell count, hemoglobin, PCV, MCV, MCHC, TPP, fibrinogen, platelets, global leukometry, segmented neutrophils, eosinophil, basophil, lymphocyte, monocyte count had no discrepant values among the animals (Table 2).

Table 1
Average values and pattern deviations of the blood parameters analyzed in specimens of wildlife *Galea spixii* from the State of Paraiba, Brazil, compared to the rodent species *Cavia porcellus* (Guinea pig)

Hematological Parameters	Values	Guinea pig values*
Red blood cell count (x10^{12}/L)	5.53 ± 1.47	5.15 ± 0.53
Hemoglobin (g/L)	139.25 ± 12.74	153.00 ± 4.90
PCV (L/L)	0.40 ± 0.02	0.46 ± 0.04
MCV (fL)	77.79 ± 18.02	77.10 ± 1.39
MCHC (g/dL)	34.12 ± 2.68	38.60 ± 0.95
TPP (g/dL)	5.77 ± 0.93	0.04 ± 0.03
Fibrinogen (g/dL)	162.50 ± 74.40	0.22 ± 0.11
Platelets (x10^{9}/L)	342.25±110.30	211.20 ± 162.70
Global Leucometry (x10^{9}/L)	1.82 ± 0.77	9.60 ± 2.00
Segmented N. (%)	44.37 ± 14.47	59.50 ± 19.00
Eosinophil (%)	1.25 ± 0.88	0.33 ± 0.50
Basophil (%)	0.5 ± 0.75	0.00
Lymphocyte (%)	45.25 ± 15.89	34.3 ± 19.1
Monocyte (%)	8.62 ± 2.26	5.8 ± 2.5
Segmented N. (x10^{9}/L)	0.78 ± 0.36	0.57 ± 0.20
Eosinophil (x10^{9}/L)	0.02 ± 0.031	0.03 ± 0.05
Basophil (x10^{9}/L)	1.06 0.009	0.00
Lymphocyte (x10^{9}/L)	0.162 ±0.114	3.17 ± 1.52
Monocyte (x10^{9}/L)	0.162 ±0.114	0.58 ± 0.34

PCV: packed cell volume; MCV: Mean Corpuscular Haemoglobin; MCHC: Mean Corpuscular Haemoglobin Concentration; TPP: total plasmatic proteins. * Reference values for Guinea pig (*Cavia porcellus*) according to L. D. P. G. Reis (2017).

Studies with cavies are not numerous even though they have high zoonotic importance because of their use as a source of protein and as pets by communities in the Brazilian Northeast (Barboza et al., 2016; Santos, 2018). Concerning the ecto-fauna for the species of *G. spixii* wildlife, this was the first report of *Gyropus ovalis, Laelaps* sp. and *Chirodiscoides caviae.* The *G. quadrisetosa* parasite was registered by Pereira (2012, 2013) and Werneck (1976) in G. spixii. Disregarding this study, Werneck (1976) described the *G. quadrisetosa* as the only parasite in *Galea spixii* cavy, even mentioning the same in *Cavia porcellus* and *Cavia aperea.*

Pereira et al. (2013) identified *Amblyomma* sp., *Demodex* sp., and *G. quadrisetosa* as natural ectoparasites in *G. spixii* bred in captivity in the Rio Grande do Norte. When in a high quantity, these parasites cause an intense itch, which makes wounds on the animal's skin, a situation that can lead to bacterial infection (Pereira et al., 2012). These characteristics were not found on the animals in this study.

Both lice and mites are rodent parasites, commonly found in subjects of the *Cavia* sp. genus, as described by Valim et al. (2004), Pereira et al. (2013), Linardi (1991, 1984, 1987), Emerson and Price (1975), Guitton et al. (1986) and Sánchez and Flores (2012). Ectoparasites present a great diversity according to the region where they are found. These variations may also be different according to the season when they were captured in each study (Alonso et al., 2020). However, Pereira et al. (2013) describes the climate season as not being an influential factor in the population of *G. quadrisetosa.*

Rodents are more often hosts for mite parasites of the Laelapidae family (Fonseca, 1958; Botelho, 1978), however in the Northeast region of Brazil, Laelapidae in *Monodelphis domestica* was registered, while in the State of Pernambuco these mite parasites were also recorded in *Monodelphis* sp. (Fonseca, 1958). F. S. Reis et al. (2008) reported in studies that rodents and marsupials present an infestation from mites of the Laelapidae family from 82% to 44%, respectively, and the mites from the Laelapidae family occurred in 64% of the analyzed rodents. Considering only the small mammals studied, it was verified that 55% of the hosts are marsupials and 45% rodents.

Chirodiscoides caviae is one of the main, or even the main, ectoparasite in Guinea pigs (*Cavia porcellus*) with 18.2% (8/38) of parasitism (D'Ovidio & Santoro, 2014; Veloso, 2015). Furthermore, the present study registered this mite occurring in wild *G. spixii* rodents. The most common mite found in Guinea pigs are *Trixacarus caviae* and *Chirodiscoides caviae* (Quesenberry & Carpenter, 2012). Still Veloso (2015) reported that the lice found in the analyzed rodents (*C. porcellus, Chinchilla lanigera, R. norvegicus, M. musculus, Mesocricetus auratus* and *Meriones unguiculatos*) were *G. porcelli* and *G. ovalis*, and that the prevalence rate on the total sample of Guinea pigs was 13.2% (5/38) and 2.6% (1/38) respectively, and that *G. porcelli* was the prevalent one.

Studies on gastrointestinal parasites in G. spixii are rare. Vicente et al. (1997) described only the parasitism of *Vianella lenti* Durette-Dessert (1968) and *Hassalstrongylus zetta* Durette-Desset (1971) in Brazil. After that, parasitism by Ancylostomidae in cavy

of this species (Queiroz et al., 2016) and by *Catenotaenia mesovitellinica* (Rêgo, 1967) was also reported.

In Guinea pigs (*Cavia porcellus*), the *Eimeria caviae* was reported (Flausino et al., 2014). This kind of protozoan, as well as the oocysts in the stool of cavies, may not have a zoonotic value, but they may cause hemorrhagic colitis, leading to diarrhea and death of the animal (Hurley et al., 1995). The coccidians may reproduce very fast, especially in young animals (Moraillon et al., 2013), which explains a significant part of the infections with moderate or intense degree found in the animals in this present study. Further studies will be able to identify and specify protozoans, and also nematodes and cestodes found.

Parasitological diseases have a global distribution, and they cause morbidity and mortality, especially in tropical and subtropical regions in underdeveloped countries. It is a public health, social, and economic problem (A. P. Oliveira et al., 2020). Rodríguez et al. (2009) alerted about an infection case by *H. diminuta* on a child, connecting the presence of rodents both inside and outside of the households.

Investigating helminths in rodents, Simões (2009) observed *Rodentolepis akodontis,* with median intensity and abundance in the rodents species of *Akodon* spp. and *O. Nigripes,* approaching that which was observed in the South of the country (Kuhnen et al., 2012). The parasitological evaluation in *R. rattus* and *M. musculus* detected the cestode *Hymenolepis diminuta,* the nematodes *Aspiculuris tetraptera* and *Syphacia obvelata*; and cysts of *Entamoeba coli* in *R. rattus* (Guimarães et al., 2014). It is indispensable to investigate parasitological diseases in wildlife animals and their interactions with the host. In that way, it helps us in conservation programs, biodiversity preservation, and public health, besides allowing interferences of the zoonotic potential after contact with the animals (Figueiredo et al., 2010; R. S. Oliveira et al., 2015).

The GAPDH gene was detected in a similar quantity in all tested experimental animals with amplification efficiency. The GAPDH is a protein associated with multiple functions, including a role in the pathogenesis of prokaryotic and eukaryotic pathogens (Sang-Sang et al., 2021; Tristan et al., 2021). Unlike other studies, the animals were healthy and did not find any infectious agents. Hemoplasmatic and bacterial infections have been reported in rodents before by other authors. Conrado et al. (2015) identified hemothropic mycoplasma in *Rattus norvegicus* (Berkenhout, 1769), captured in two Brazilian zoos. In Japan, Sashida et al. (2013) detected mycoplasma in rats from the same species, captured during the rodent control around an animal hospital. Vieira et al. (2009) detected mycoplasma *Hydrochaeris hydrochaeris* (Linnaeus, 1766) in the south of Brazil. Gonçalves (2016) characterized the occurrence *Mycoplasma* and Bartonella in 51 species of rodents sampled in 13 states, distributed in five Brazilian biomes. Other studies with *Mycoplasma* in rodents show a significant impact of infection by *M. pulmonis,* which interferes with interpreting the experimental results obtained with infected animals (Tedesco et al., 2011).

Gazeta et al. (2004) reported the occurrence of *Babesia* sp. in small rodents (*Rattus norvegicus* and *Oligoryzomys*

nigripes) in Brazil with general infection prevalence of 27.3%, confirming previous studies from Shih et al. (1997) that also reported the infection in rodents (*Rattus coxinga*) from rural zones of Taiwan, close to highly populated areas, calling the attention to the risk of human Babesiosis and alerting to the evident emergency of research in species with host potentials of parasites and their unknown vectors. Therefore, it is of fundamental importance to detect and identify these hemoparasites in the *G. spixii* due to the potential risk of introducing possible infected specimen of this species in zoos, urban areas and households, due to the transport, interaction, manipulation, import, and transfer of these animals (B. S. Lima et al., 2013).

Regarding the hematological profile, the values of reference were compared with the ones from Brustolin et al. (2015), P. B. B. M. Barbosa et al. (2008), and Araújo (2010), by using values related to the same species *G. spixii* kept in captivity, and of *C. porcellus* because of the similarities between them. The average blood count of the animals remained normal when comparing the referent values for the *G. spixii.* However, when compared with the values for *C. porcellus* there were considerable changes. The average values found for the platelets, and leukocytes numbers were inferior to the referent values found by Brustolin et al. (2015) and Araújo (2010). Also, the monocytes number was superior. The comparative analyses of date from the hematological results presented differences with those described in literature, showing that there are variations between different genres of rodents (*G. spixii* and *C. porcellus*), even the ones with very similar characteristics. Some less significant differences were observed, probably caused by the environment, animal handling, collection method, and parasitism.

It is necessary for these alterations to be considered during the evaluation of this species, whatever the goal is (C. M. Lima et al., 2014). This information may be helpful for control groups, but they do not exclude new determinations each time the animals are kept in different experimental conditions. The results of the hematological parameters aim at establishing values for the *G. spixii* of normal homeostasis for comparison between research studies carried out with this species, especially in modifications induced by pathological processes, in standard clinical patterns and in results gained from experimental procedures.

Studies with the cavies as animal models should be encouraged because, among other characteristics, *Galea spixii* are very similar to the Cavia genre; they are small and docile animals that can be easily manipulated and housed, have a short gestational period, and high reproductive levels, which helps to reduce research costs (Carter & Mess, 2007). Their relationship in the epidemiological chain of zoonotic diseases is still not understood, and therefore studies in this direction should be encouraged, particularly in Brazil.

Conclusion

We report the parasitism of wild *Galea spixii* by *Gliricola quadrisetosa, Gyropus ovalis, Laelaps* sp. and *Chirodiscoides caviae* ectoparasites. Nematode eggs, Cestode eggs, and oocysts from Coccidians were found in the feces exams. Molecular analysis

did not detect Mycoplasma sp., Babesia sp., Ehrlichia sp. and Bartonella sp in these rodents. The results found in the blood count of wild cavies show similarities to values used as reference for the same species in captivity. The aspects studied are relevant for the health of the species, other animals, and human health, to identify, describe, and prevent risks to life from disseminating pathogens. Therefore, studies with little-explored species, and that may be carriers and hosts of parasites and zoonosis, is very important.

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Declaration of conflict of interest

The authors declare that they have no conflict of interest.

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