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ORIGINAL ARTICLE / ARTÍCULO ORIGINAL

# GIARDIASIS OUTBREAK *IN SITU* SOUTHERN TAMANDUAS (*TAMANDUA TETRADACTYLA* LINNAEUS, 1758) UNDERGOING REHABILITATION: CLINICAL FINDINGS, THERAPEUTIC MANAGEMENT, AND PROGNOSIS

# BROTE DE GIARDIASIS EN OSOS HORMIGUEROS MENORES (*TAMANDUA TETRADACTYLA* LINNAEUS, 1758) *IN SITU* EN PROCESO DE REHABILITACIÓN: HALLAZGOS CLÍNICOS, TERAPÉUTICOS Y PRONÓSTICO

# SURTO DE GIARDÍASE EM TAMANDUÁS-MIRINS (*TAMANDUA TETRADACTYLA* LINNAEUS, 1758) *IN SITU* EM PROCESSO DE REABILITAÇÃO: ACHADOS CLÍNICOS, TERAPÊUTICOS E PROGNÓSTICO

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Running Head: Giardiasis outbreak *in situ* southern tamanduas

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**ABSTRACT**

*Giardia* is an intestinal protozoan disease responsible for parasitizing a wide range of vertebrates, with transmission occurring through contaminated water and food containing cysts released by infected hosts. Given this context, the present study aimed to describe an outbreak of giardiasis in three southern tamanduas (*Tamandua tetradactyla* Linnaeus, 1758) undergoing rehabilitation in the state of Sergipe, Brazil, as well as the clinical and therapeutic aspects of this disease. A male specimen that died abruptly, presenting anorexia, malnutrition, cachexia, and diarrheic feces, was submitted for necropsy analysis at the Animal Pathology Department of the Federal University of Sergipe – São Cristóvão Campus. Gastric content analysis, urinalysis, bone marrow smear, and fecal parasitological examination were performed, identifying the presence of cysts and trophozoites of *Giardia duodenalis* Stiles, 1902. Subsequently, the other animals sharing the same enclosure—a female and a male presenting diarrheic feces—were referred for clinical care at the Wildlife Animal Sector of the Veterinary Hospital of the Federal University of Sergipe – São Cristóvão Campus. Complete blood count, serum biochemistry, and fecal parasitological examinations were performed on both animals, revealing the presence of *G. duodenalis* cysts. Treatment with Metronidazole, along with environmental and dietary management, was instituted. After completion of treatment, the animals were re-evaluated, showing resolution of diarrheic episodes and improvement in nutritional status, and a new fecal parasitological examination was conducted, with no *G. duodenalis* cysts or trophozoites observed. This study revealed previously unreported clinical alterations associated with *Giardia* infection in this species, as well as describing the therapeutic approach employed, contributing significantly to the medicine of xenarthrans.

**Keywords:** Clinical Signs – Cysts – *Giardia* – Trophozoites

**RESUMEN**

*Giardia* es un protozoo intestinal responsable de parasitar una amplia variedad de vertebrados, cuya transmisión ocurre a través del agua y alimentos contaminados que contienen quistes liberados por hospedadores infectados. Dado este contexto, el presente estudio tuvo como objetivo describir un brote de giardiasis en tres tamandúas del sur (*Tamandua tetradactyla* Linnaeus, 1758) en proceso de rehabilitación en el estado de Sergipe, Brasil, así como los aspectos clínicos y terapéuticos de esta enfermedad. Un ejemplar macho que murió abruptamente, presentando anorexia, desnutrición, caquexia y heces diarreicas, fue sometido a un análisis de necropsia en el Departamento de Patología Animal de la Universidad Federal de Sergipe – Campus São Cristóvão. Se realizaron análisis del contenido gástrico, análisis de orina, frotis de médula ósea y examen parasitológico fecal, identificándose la presencia de quistes y trofozoítos de *Giardia duodenalis* Stiles, 1902. Posteriormente, los otros animales que compartían el mismo recinto —una hembra y un macho que presentaban heces diarreicas— fueron remitidos para atención clínica al Sector de Animales Silvestres del Hospital Veterinario de la Universidad Federal de Sergipe – Campus São Cristóvão. Se realizaron hemograma completo, bioquímica sérica y exámenes parasitológicos fecales en ambos animales, revelando la presencia de quistes de *G. duodenalis*. Se instauró tratamiento con metronidazol, junto con manejo ambiental y dietético. Después de completar el tratamiento, los animales fueron reevaluados, mostrando resolución de los episodios diarreicos y la mejoría del estado nutricional, y se realizó un nuevo examen parasitológico fecal, sin observarse quistes ni trofozoítos de *G. duodenalis*. Este estudio reveló alteraciones clínicas previamente no descritas asociadas con la infección por *Giardia* en esta especie, además de describir el abordaje terapéutico empleado, contribuyendo significativamente a la medicina de los xenartros.

**Palabras clave:** *Giardia* – Quistes – Signos clínicos – Trofozoítos

**RESUMO**

*Giardia* é um protozoário intestinal responsável pelo parasitismo de uma ampla variedade de vertebrados, cuja transmissão ocorre por meio de água e alimentos contaminados com cistos eliminados por hospedeiros infectados. Diante desse contexto, o presente estudo teve como objetivo descrever um surto de giardíase em três tamanduás-mirins (*Tamandua tetradactyla* Linnaeus, 1758) em processo de reabilitação no estado de Sergipe, Brasil, bem como os aspectos clínicos e terapêuticos dessa doença. Um espécime macho, que morreu de forma súbita, apresentando anorexia, desnutrição, caquexia e fezes diarreicas, foi encaminhado para análise necroscópica no Departamento de Patologia Animal da Universidade Federal de Sergipe – Campus São Cristóvão. Foram realizadas análises do conteúdo gástrico, urinálise, esfregaço de medula óssea e exame parasitológico de fezes, sendo identificada a presença de cistos e trofozoítos de *Giardia duodenalis* Stiles, 1902. Posteriormente, os outros animais que compartilhavam o mesmo recinto — uma fêmea e um macho que apresentavam fezes diarreicas — foram encaminhados para atendimento clínico no Setor de Animais Silvestres do Hospital Veterinário da Universidade Federal de Sergipe – Campus São Cristóvão. Em ambos os animais, foram realizados hemograma, exames bioquímicos séricos e exames parasitológicos de fezes, que revelaram a presença de cistos de *G. duodenalis*. Foi instituído tratamento com metronidazol, associado a medidas de manejo ambiental e alimentar. Após a conclusão do tratamento, os animais foram reavaliados, apresentando resolução dos episódios de diarreia e melhora do estado nutricional, e foi realizado um novo exame parasitológico de fezes, no qual não foram observados cistos ou trofozoítos de *G. duodenalis*. Este estudo revelou alterações clínicas ainda não relatadas anteriormente associadas à infecção por *Giardia* nessa espécie, além de descrever a abordagem terapêutica empregada, contribuindo significativamente para o conhecimento da medicina de xenartros.

**Palavras-chave:** Cistos – *Giardia* – Sinais clínicos – Trofozoítos

## INTRODUCTION

The superorder Xenarthra is represented by an ancestral group of animals of South American origin, divided into the orders Cingulata, represented by armadillos, and Pilosa, which includes sloths and anteaters (Portillo *et al*., 2022; Oliveira *et al*., 2023). Anteaters are a group of placental mammals distributed into four species worldwide (Oliveira *et al*., 2023), three of which occur in Brazil: the silky anteater (*Cyclopes didactylus* Linnaeus, 1758), giant anteater (*Myrmecophaga tridactyla* Linnaeus, 1758), and southern tamandua (*Tamandua tetradactyla* Linnaeus, 1758) (Bertassoni *et al*., 2022).

Present in all Brazilian biomes, the southern tamandua (*T. tetradactyla*), also known as the collared anteater, is an obligate insectivore native to South America (Oliveira *et al*., 2023). These animals are discreet and nocturnal, possessing a prehensile tail and short, dense fur with dark-brown and golden-white coloration (Portillo *et al*., 2022). They exhibit regional dimorphism, with northern populations presenting darker fur and longer body, snout, and ears; Atlantic Forest populations displaying lighter fur and a more defined “vest”; and Cerrado populations showing a more golden coloration (Bertassoni *et al*., 2022; Oliveira *et al*., 2023).

*Giardia* (Kunstler, 1882) is an intestinal protozoan with significant impact on a wide range of vertebrates, including birds, amphibians, reptiles, humans, and wild and domestic mammals (Fehlberg *et al*., 2021; Gil *et al.*, 2025). Its dissemination mainly occurs through waterborne transmission and contaminated food containing cysts shed by infected hosts (Procesi *et al*., 2022). *Giardia* spp. cysts have been reported in different mammalian species from the families Atelidae, Canidae, Cricetidae, Didelphidae, Felidae, and Procyonidae inhabiting the North, Northeast, South, and Southeast regions of Brazil (Pantoja *et al*., 2017; Barbosa *et al*., 2019; Fehlberg *et al*., 2021; Lignon *et al*., 2025).

The genus *Giardia* is divided into the species *G. agilis* (Kunstler, 1882) in amphibians, *G. ardeae* (Erlandsen, 1990) and *G. psittaci* (Erlandsem & Bemrick, 1987) in

birds, *G. microti* (Christiansen, 1915), *G. muris* (Grassi, 1879), and *G. cricetidarum* (Waldheim, 1817) in rodents, *G. duodenalis* (Stiles, 1902) in vertebrates and humans, and *G. paramelis* (Hillman, 2016) in Australian marsupials (Dixon, 2021; Tawana *et al*., 2022; Echeverry *et al*., 2025). Fecal parasitological examinations are essential for the diagnosis of gastrointestinal protozoa in captive animals, as these agents are associated with alterations in the digestive system (Liu *et al*., 2021). Species such as *G. duodenalis* present a broad host range and zooanthroponotic and zoonotic transmission cycles, favoring outbreaks associated with cyst-contaminated sources, especially water, particularly in Wildlife Screening Centers (CETAS) located near urban centers (Barbosa *et al*., 2019; Gil *et al*., 2025).

Given the need for studies addressing the epidemiological aspects, clinical alterations, and therapeutic protocols in captive xenarthrans affected by gastrointestinal protozoa, the present study aimed to describe an outbreak of giardiasis in southern tamanduas (*T. tetradactyla*) and their respective clinical and therapeutic aspects in the state of Sergipe, Northeastern Brazil.

## MATERIALS AND METHODS

An outbreak of giardiasis affecting three southern tamanduas (*T. tetradactyla*) was identified at the Wildlife Screening Center (CETAS) located in the state of Sergipe, Brazil. The animals were attended by the team of the Veterinary Teaching Hospital of the Federal University of Sergipe – São Cristóvão Campus (HVU-UFS). All individuals had been maintained at the rehabilitation center for more than one year, receiving a diet based on vegetables, with a previous history of deworming and vaccination. At the Animal Pathology Laboratory of the Federal University of Sergipe – São Cristóvão Campus, fecal, urine, bone marrow samples, hemoparasites and inclusion bodies, hematological and serum biochemical samples from southern tamanduas were collected for clinical analyses.

**Ethical aspects**: Submission of the present study for review by an Ethics Committee was not required. This is a descriptive report of three clinical cases involving animals treated concurrently at the HVU-UFS.

## RESULTS

The outbreak began with an approximately 8-month-old male (Case 1) presenting anorexia and diarrhea, progressing to death within less than 24 h after the onset of clinical signs. The animal was referred for necropsy at the Animal Pathology Laboratory of the Federal University of Sergipe – São Cristóvão Campus, where fecal, urine, and bone marrow samples were collected for clinical analyses. Urinalysis revealed light-yellow and clear urine (RI: Straw yellow – Citrine yellow), with glycosuria (++++; RI: +-), proteinuria (+++; RI: Negative), pH 7.0 (RI: 6,0-8,0), specific gravity of 1.020 (RI: 1.012-1.028), bacteriuria (Positive; RI: Negative-Rare), hematuria (1-3; RI: Rare), and leukocyturia (1-3; RI: Rare) (Reisfeld *et al*., 2013).

The bone marrow sample was negative for hemoparasites and inclusion bodies. Fecal content analyzed by direct examination and the Willis-Mollay sucrose flotation technique revealed, under 100× and 400× magnification, oval structures containing four nuclei measuring 8–12 × 7–10 µm and bilaterally symmetrical pyriform structures measuring 12–15 × 5–9 µm, compatible with *G. duodenalis* cysts and trophozoites, respectively, with approximately 20 cysts per field (Figures 1 and 2).

According to these findings, the other two rescued southern tamanduas (*T. tetradactyla*) sharing the same enclosure were referred for clinical evaluation at the Wildlife Medicine Sector of HVU-UFS on the following day. These included a juvenile female (Case 2), weighing 3.700 kg, and a young male (Case 3), weighing 3.200 kg, both undergoing rehabilitation at CETAS.

Physical examination revealed bloody perianal diarrhea and abdominal gas accumulation upon palpation in both animals. Hematological and serum biochemical

alterations were observed. *Case 2* presented erythrocytosis, polycythemia, neutropenia, mild leukocytosis due to lymphocytosis, elevated alkaline phosphatase (ALP), hyperalbuminemia, and hyperglobulinemia. *Case 3* showed plasma hypoproteinemia, eosinopenia, lymphopenia, leukocytosis due to neutrophilia with left shift, low alanine aminotransferase (ALT) levels, hyperproteinemia, hyperalbuminemia, and azotemia (Tables 1 and 2).

Fecal samples from both patients were collected and submitted for parasitological examination using the same methodology described for *Case 1*, revealing a high burden of *G. duodenalis* cysts. The therapeutic protocol consisted of Metronidazole administration (15 mg/kg/PO/SID) for five days, in addition to enclosure disinfection and environmental and dietary management adjustments. After seven days, the animals underwent a new clinical evaluation, demonstrating improved activity levels, absence of diarrhea, and feces with normal appearance for the species. Furthermore, no *G. duodenalis* cysts or trophozoites were detected in fecal parasitological examinations using direct examination and Willis-Mollay sucrose flotation.

## DISCUSSION

The present study describes an outbreak of giardiasis affecting three southern tamanduas (*T. tetradactyla*) undergoing rehabilitation at a Wildlife Screening Center (CETAS) in the state of Sergipe, Brazil, with one of the animals progressing to death.

*G. duodenalis* is considered the only species with zoonotic potential capable of infecting domestic and wild animals (Al-Joubouri & Al-Awadi, 2023; Gil *et al.*, 2025). Parasites of this genus play an important role in the population dynamics of wild species, directly interfering with phenotypic and genetic diversity, as well as with the clinical aspects of their hosts (Lignon *et al*., 2025). Infections by *Giardia* in myrmecophagids such as *M. tridactyla* and *T. tetradactyla* have been reported in countries including Brazil, China, and

Poland (Pencheva, 2013; Liu *et al.,* 2021). Affected animals may exhibit clinical signs such as lethargy, anorexia, malabsorption, weight loss, impaired growth, and acute or chronic diarrhea, either continuous or intermittent, as observed in the three anteaters described in the present study (Tangtrongsup *et al*., 2019; Nahavandi *et al*., 2025) (Figure 3).

Previous studies have demonstrated the influence of giardiasis on glucose and lipid metabolism, with infected hosts presenting hyperglycemia and dyslipidemia (Al-Joubouri & Al-Awadi, 2023; Ribeiro *et al*., 2025). The glycosuria observed in the urinalysis of the *T. tetradactyla* that progressed to death may be associated with inhibition of insulin activity caused by protozoan metabolites, resulting in increased serum glucose levels (Klimczak *et al.*, 2024). Furthermore, according to Ribeiro *et al.* (2025), giardiasis may significantly impact hosts with metabolic disorders, since hyperglycemia associated with dyslipidemia stimulates pro-inflammatory mechanisms, increasing insulin resistance and inhibiting insulin secretion.

Case 2 presented erythrogram alterations characterized by increased erythrocyte count, hemoglobin concentration, and hematocrit values. These findings are indicative of more viscous and concentrated blood as a consequence of dehydration, resulting in plasma volume reduction and erythrocyte concentration (Song *et al.*, 2020). Animals affected by giardiasis may develop intestinal malabsorption of fluids and electrolytes due to structural alterations of intestinal microvilli caused by parasitism (Ragbetli *et al*., 2014; Boucard *et al*., 2021; Ribeiro *et al*., 2025).

On leukogram evaluation, the same animal presented leukocytosis due to lymphocytosis and neutropenia. Similar findings were reported in an experimental study involving rats with giardiasis, in which an increase in circulating lymphocytes was observed (Abo-Zaid & Hamdi, 2022). It is well established that parasitic infections increase the number of circulating B and T lymphocytes in response to parasitism (Serradell *et al*., 2018; Maertens *et al.,* 2021). In particular, T lymphocytes are responsible for producing lymphokines that stimulate the migration of phagocytic cells to inflammatory sites, whereas

B lymphocytes play an important role in immunoglobulin production (Garzon *et al*., 2021; Abo-Zaid & Hamdi, 2022).

In the leukogram of *Case 3*, leukocytosis associated with neutrophilia and left shift was observed, indicating a regenerative inflammatory response. Such alterations may indicate inflammatory processes intrinsically related to intestinal inflammation caused by the protozoan infection (Al-Joubouri & Al-Awadi, 2023; Klimczak *et al*., 2024). High intestinal parasitic burdens of *Giardia* spp. are responsible for inducing inflammatory processes as a result of structural damage and shortening of intestinal microvilli, enterocyte exfoliation, and peripheral membrane lesions of the intestinal epithelium (Benchimol, 2020; Boucard *et al*., 2021).

Experimental studies previously conducted in Mongolian gerbils (*Meriones unguiculatus* Edwards, 1867) have investigated the influence of giardiasis on metabolism and basal enzyme levels (Araújo *et al*., 2008; Ribeiro *et al.,* 2025). A mild and nonspecific increase in ALT has been described, generally associated with lesions in organs other than the liver, excluding hepatic involvement (Gil *et al*., 2025). In contrast, hypoalanine aminotransferasemia was observed in *Case 3* in the present study. Increased ALP levels were observed in *Case 2*. ALP is an enzyme present in biliary duct cells, bones, placenta, and intestines. Enterocyte damage resulting from parasitism within intestinal crypts, causing hyperplasia and increased epithelial cell mitosis, may lead to elevated circulating levels of this enzyme (Gil *et al*., 2025).

Additionally, similarly to previous experimental studies, hyperalbuminemia was observed in both animals. Increased albumin levels are expected due to enhanced protein catabolism resulting from the inflammatory response associated with giardiasis (Gil *et al*., 2025). Elevated serum protein levels are intrinsically related to increased immunoglobulin synthesis, also contributing to increased total protein concentrations and elevated globulin levels, as observed in *Case 2* (Shima *et al.,* 2022; Cagnasso *et al*., 2023).

The occurrence of azotemia in the biochemical profile, associated with increased urea levels, has been reported as a consequence of reduced glomerular filtration rate caused by dehydration and hypovolemia (Ragbetli *et al*., 2014). Increased urea concentrations have also been reported in dogs affected by giardiasis due to gastrointestinal hemorrhagic processes caused by parasitism (Safrany *et al*., 2023). Furthermore, intestinal disorders such as diarrhea, observed in the *T. tetradactyla* from *Case 3*, may induce electrolyte imbalance, consequently increasing renal biomarkers such as urea and creatinine (Ragbetli *et al.,* 2014; Al-Joubouri & Al-Awadi, 2023).

Eosinophilia is generally considered a common finding in parasitic infections caused by helminths and protozoa, since eosinophils actively participate in direct parasite elimination (Ofori *et al*., 2025). Contrary to the findings reported in an experimental study involving albino rats with giardiasis conducted by Abo-Zaid & Hamdi (2022), which described eosinophilia associated with both protozoan infection and hypersensitivity reactions leading to histamine release, eosinopenia was observed in *Case 3*. According to Jasim (2020), reduced eosinophil counts may occur because these cells actively migrate to tissues affected by the protozoan, particularly the intestine, decreasing their concentration in circulation while increasing their presence at the infection site.

As demonstrated in the present study, there is still a limited number of investigations addressing the epidemiological and clinical aspects of *Giardia* infection in captive mammals maintained in conservation parks, zoos, and rehabilitation centers (Liu *et al*., 2021; Nahavandi *et al*., 2025). Even in controlled environments, such facilities may favor maintenance of the epidemiological cycle due to the availability of hosts from different species and direct transmission among confined animals (Kamel & Abdel-Latel, 2021; Esteban-Sánchez *et al*., 2025). In addition, factors such as captivity-related stress, high animal density, and poor enclosure sanitation have been identified as contributing factors increasing susceptibility and exposure to infection (Šmit *et al*., 2023; An *et al*., 2024).

The adoption of biosecurity and biosafety strategies aimed at preventing *Giardia* infections is considered essential and has been increasingly applied in wildlife rehabilitation and conservation centers (Kamel & Abdel-Latel, 2021; Esteban-Sánchez *et al.,* 2025). The implementation of feeding management protocols combined with sanitary surveillance of food and water quality provided to captive animals constitutes a fundamental measure for interrupting the transmission cycle of the protozoan (Liu *et al.*, 2021; An *et al*., 2024). Furthermore, isolation and reduction of contact between infected animals and other animals or professionals, the establishment of quarantine areas and internal zoning within conservation centers, as well as regular enclosure cleaning and disinfection, are recommended to minimize the risk of environmental contamination (Kamel & Abdel-Latel, 2021; Liu *et al*., 2021; Esteban-Sánchez *et al*., 2025).

The present study describes an outbreak of giardiasis affecting three southern tamanduas (*T. tetradactyla*) undergoing rehabilitation at a Wildlife Screening Center (CETAS) in the state of Sergipe, Brazil. Novel clinical alterations associated with infection in this species were identified, along with the therapeutic management adopted, thereby contributing significantly to the field of xenarthran medicine. Furthermore, the importance of implementing rigorous biosafety and biosecurity protocols during wildlife rehabilitation is emphasized to prevent outbreaks caused by protozoa of this genus, limit their dissemination among animals, and avoid potential losses associated with the parasite.

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503 **Table 1.** Hematological profile of southern tamandua (*Tamandua tetradactyla*) specimens,

504 *Case 2* and *Case 3*.

| **Erythrogram** | | | | | | |
|---|---|---|---|---|---|---|
| | **Reference** | | ***Case 2* Result** | | ***Case 3* Result** | |
| Erythrocytes (x$10^6$/µL) | 2.63 – 3.67 | | 3.87 | | 2.99 | |
| Hemoglobin (g/dL) | 9.46 – 12.0 | | 14.2 | | 10.9 | |
| Hematocrit (%) | 31.5 – 38.1 | | 44.6 | | 35 | |
| MCV (fl) | 99.8 – 132 | | 115.3 | | 117 | |
| MCH (pg) | 31.0 – 40.0 | | 36.8 | | 36.4 | |
| MCHC (%) | 27.5 – 34.7 | | 31.9 | | 31.2 | |
| TP (g/dL) | 8.5 – 9.3 | | 9.0 | | 8,0 | |
| Platelets (x$10^3$/ µL) | 180 – 370 | | - | | 298 | |
| **Leukogram** | | | | | | |
| | | | ***Case 2*** | | ***Case 3*** | |
| | **RR (%)** | **RA** | **RR* (%)** | **RA*** | **RR* (%)** | **RA*** |
| Leukocytes (/µL) | - | 5790 – 10340 | - | 11330 | - | 10770 |
| Band Neutrophils | 0 | 0 | 0 | 0 | 4 | 431 |
| Segmented Neutrophils | 39 – 57 | 2620 – 4980 | 17 | 1926 | 85 | 9155 |
| Basophils | 0 | 0 | 0 | 0 | 0 | 0 |
| Eosinophils | 4-8 | 220 – 680 | 3 | 340 | 0 | 0 |
| Lymphocytes | 35 – 53 | 2240 – 5060 | 79 | 8951 | 9 | 969 |
| Monocytes | 1 – 3 | 70 – 220 | 1 | 113 | 1 | 215 |

505 MCV: Mean Corpuscular Volume
506 MCH: Mean Corpuscular Hemoglobin
507 MCHC: Mean Corpuscular Hemoglobin Concentration
508 TP: Total Protein
509 RR: Relative Reference Range
510 RA: Absolute Reference Range
511 RR*: Relative Result
512 RA*: Absolute Result
513

514 **Table 2.** Serum biochemical profile of southern tamandua (*Tamandua tetradactyla*)

515 specimens, *Case 2* and *Case 3*.

| **Serum Biochemistry** | **Reference** | **Unit** | ***Case 2* Result** | ***Case 3* Result** |
|---|---|---|---|---|
| Aspartate Aminotransferase (AST/SGOT) | 19 – 85 | U/L | 24 | 20 |
| Alanine Aminotransferase (ALT/SGPT) | 50 – 90 | U/L | 67 | 45 |
| Alkaline Phosphatase (ALP) | 11 – 60 | U/L | 104 | 29 |
| Total Protein (TP) | 6.16 – 7.09 | g/dL | 9.3 | 8.7 |
| Albumin | 1.01 – 1.82 | g/dL | 3.3 | 3.1 |
| Globulin | 5.02 – 5.8 | g/dL | 6.0 | 5.6 |
| Albumin: Globulin Ratio (A: G Ratio) | - | - | 0.55 | 0.55 |
| Urea | 42.0 – 67.0 | mg/dL | 60.1 | 96.3 |
| Creatinine | 0.36 – 1.16 | mg/dL | 1.01 | 1.13 |

516

**Figure 1.** Location of the region, state, and municipality where the giardiasis outbreak in anteaters occurred.

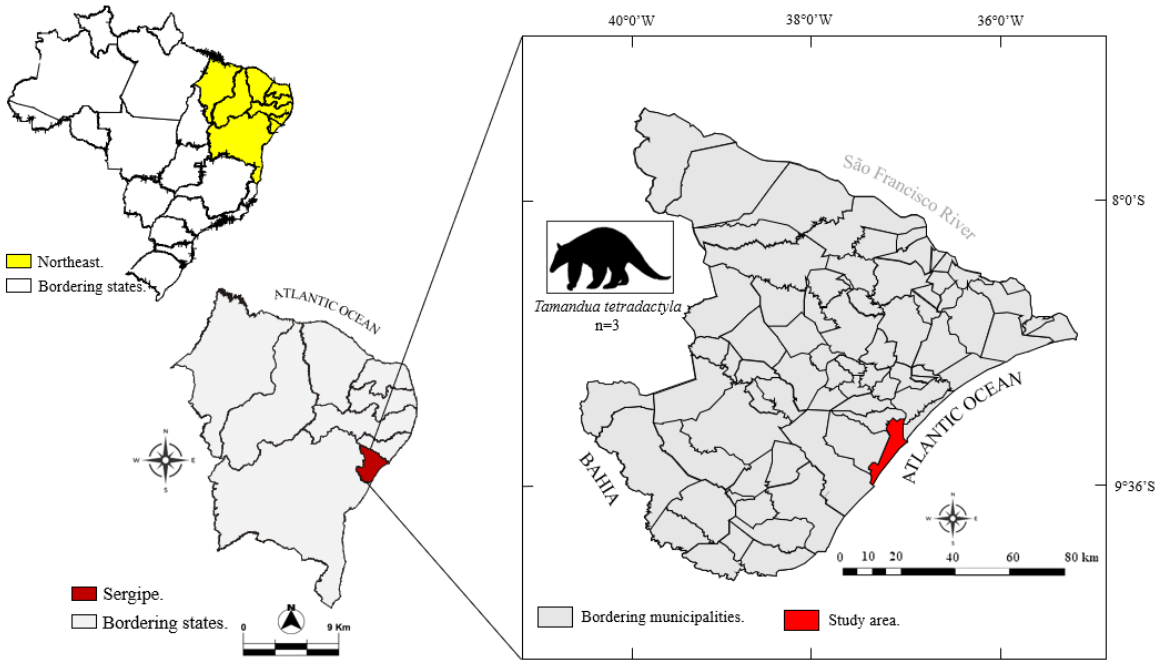

**Figure 2.** *Giardia duodenalis* cysts (arrow) observed in a fecal sample from a southern tamandua (*Tamandua tetradactyla*).

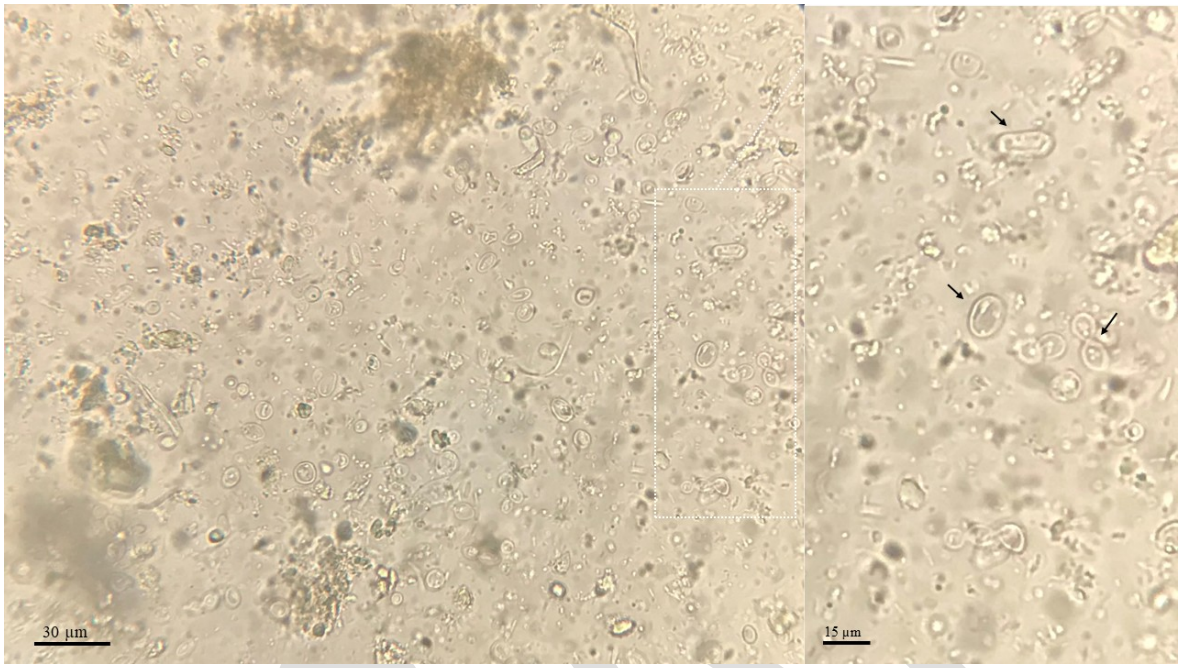


**Figure 3.** Life Cycle of *Giardia duodenalis* in Myrmecophagids and Humans.