DOI: https://doi.org/10.62015/np.2023.v29.779

CONSERVATION AND RESEARCH EFFORTS FOR GEOFFROY'S SPIDER MONKEY *(ATELES GEOFFROYI)* IN EL SALVADOR

Luis E. Girón-Galván
Karla Zaldaña-Orantes
Lucía Sanchéz-Trejo
Elena Castillo
Melissa E. Rodríguez

Abstract

Geoffroy's spider monkey (*Ateles geoffroyi*) is considered one of the World's 25 Most Endangered Primates. It is the only non-human primate in El Salvador and its presence has been confirmed in six small forest patches in the southeast of the country. In El Salvador, the species is threatened by habitat loss, fragmentation, and forest fires, leading to the loss of connectivity among the forest patches the species inhabits. Due to species' vulnerability and the lack of knowledge about its status, the *Ateles* Conservation Program in El Salvador has been leading conservation efforts to increase the state of knowledge of the species in the country since 2013. For example, there has been a study of genetic diversity of *A. geoffroyi* and their genetic population structure in Xirihualtique-Jiquilisco Biosphere Reserve. Moreover, there have been new reports by local communities in at least three locations around the country, suggesting the species has a broader distribution than previously known. As a result of collaborative work between governmental and non-governmental institutions over the last 10 years, we have developed guidelines for conservation actions to help spider monkeys in threatened ecosystems in the country. Now we have a strategic plan and are beginning a new stage in conservation efforts for the only wild primate in El Salvador.

Keywords: endangered species, genetic diversity, local distribution, primates, strategic plans

Resumen

El mono araña de Geoffroy (*Ateles geoffroyi*) es considerado uno de los 25 primates más amenazados en el mundo. Es el único primate no humano en El Salvador y su presencia ha sido confirmada en seis pequeños parches de bosque al sureste del país. En El Salvador, la especie enfrenta varias amenazas como la pérdida de hábitat, fragmentación e incendios forestales, que llevan a la pérdida de conectividad entre los relictos de bosque donde habita la especie. Debido a la vulnerabilidad de los monos araña y a los vacíos de conocimiento sobre la especie en el país, el programa de conservación *Ateles* en El Salvador ha estado haciendo esfuerzos de conservación desde el 2013 para incrementar el estado de conocimiento de la especie en el país. Ahora conocemos la diversidad genética de *A. geoffroyi* y su estructura en la Reserva de Biosfera Xirihualtique-Jiquilisco. Adicionalmente, hay nuevos reportes de la especie en tres comunidades locales alrededor del país, sugiriendo que la distribución es más amplia de lo documentado. Como resultado del trabajo colaborativo por 10 años con instituciones de gobierno y privadas, hemos desarrollado lineamientos para hacer acciones de conservación para ayudar a los monos araña en los ecosistemas amenazados del país. Ahora se tiene un plan estratégico y es el inicio de una nueva etapa en los esfuerzos de conservación del único primate silvestre en El Salvador.

Palabras clave: distribución local, diversidad genética, especies en peligro, primates, planes estratégicos

Introduction

Geoffroy's spider monkey (*Ateles geoffroyi*) is considered one of the World's 25 Most Endangered Primates (Méndez-Carvajal et al., 2022), and is listed as Endangered on the IUCN Red List (Cortés-Ortíz et al., 2021). The species is present in México, Guatemala, Nicaragua, El Salvador, Belize, Honduras, Costa Rica and Panama (Rylands et al., 2006). *A. geoffroyi* is the only non-human primate naturally occurring in El Salvador and is listed as Critically Endangered by the Ministry of Environment and Natural Resources of El Salvador (MARN, 2015). It has been reported in Normandía Natural Area (NA), Chaguantique Natural Protected Area (NPA), El Tercio and El Nacascolo in Xirihualtique-Jiquilisco Biosphere Reserve, Cerro El Mono and El Caballito NPA in the Jucuarán mountain range, and Olomega lagoon (Burt and Stirton, 1961; Morales-Hernández, 2003; Argueta-Rivas and Rivera-Hernández, 2004; Rodríguez-Menjivar, 2007; Owen and Girón, 2012; Pineda et al., 2017; Pineda et al., 2020; see Figure 1). There are some sites where the species is potentially present but has not been adequately documented such as Montecristo Island, Conchagua and Montecristo National Park (Figure 1).

In El Salvador, the species faces several threats such as habitat loss, fragmentation, and forest fires, which have led to the loss of connectivity among the forest patches inhabited by the species. Spider monkey populations in El Salvador have been very fragmented since at least the 1920's. According to Hampshire (1989) primary forest in El Salvador in the 1980´s was only 2% of the territory. However, the latest data suggest that El Salvador has 14% of its natural forests remaining (Crespín and Simonetti, 2015). However only 9% are natural protected areas (Medrano and Hernández, 2017), the lowest coverage of natural protected areas in Latin America (Crespín and Simonetti, 2015).

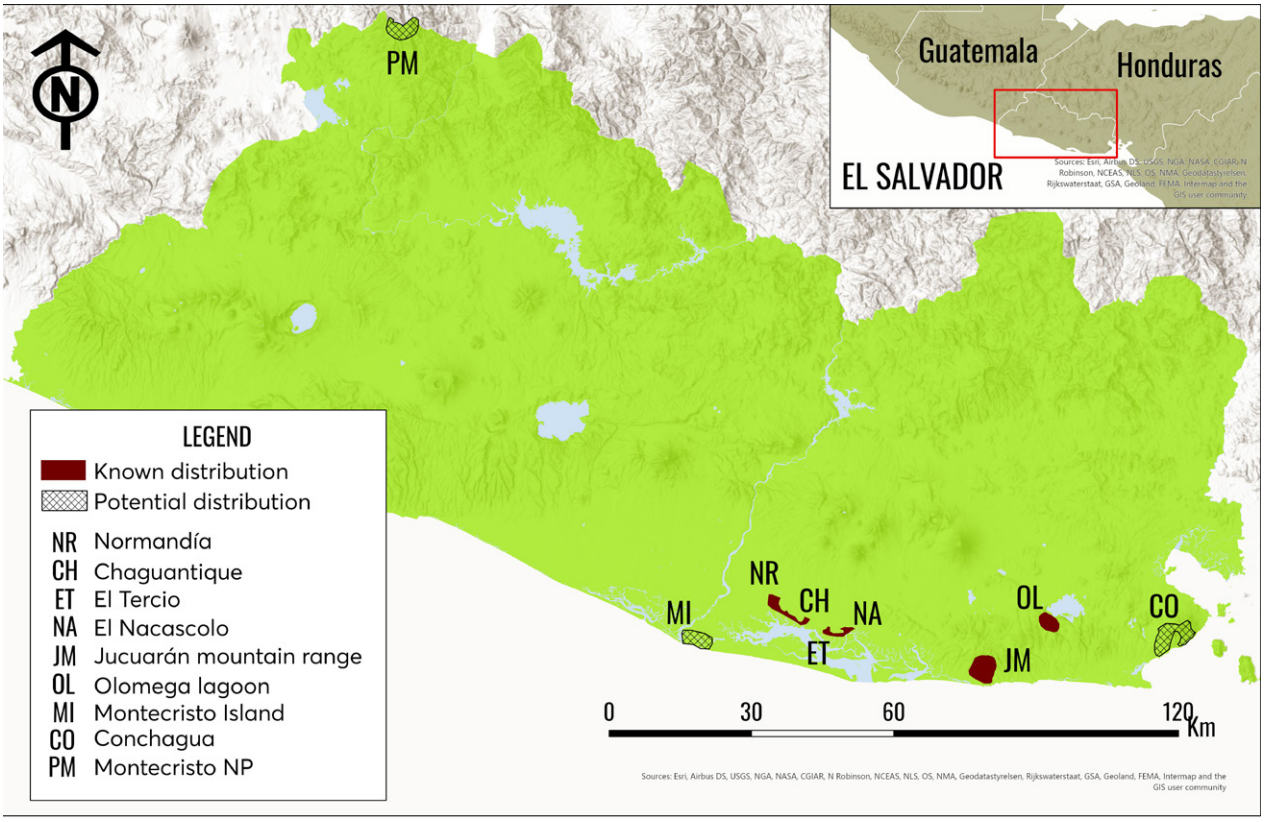

Figure 1. Distribution of *Ateles geoffroyi* in El Salvador (Source: Girón, 2022).

Here we present a synthesis of efforts to study and conserve spider monkeys in El Salvador over the last 20 years, as well as plans for future work. Asociación Territorios Vivos El Salvador has been leading conservation efforts to preserve the species and to increase knowledge about *Ateles geoffroyi* in El Salvador since 2013, when the *Ateles* Conservation Project began thanks to support from the Mohamed bin Zayed Species Conservation Fund. This project led to data collection on diet and behavior, as well as fecal sample collection for genetic studies, environmental education activities with local communities, and planning concrete conservation action with local government.

Studies of *Ateles geoffroyi* in El Salvador

The first scientific record of *Ateles geoffroyi* in El Salvador is from 1925 (Burt and Stirton, 1961), however research efforts began only in the 2000's in Chaguantique, Normandía and El Tercio (Morales-Hernández, 2003; Argueta-Rivas and Rivera-Hernández, 2004; Rodríguez-Menjivar, 2007). These studies provided the first reports of spider monkey population density, sex ratio (Table 1), habitat use, and diet in El Salvador, setting a baseline of data to be able to identify possible fluctuations and changes in the populations.

Research and conservation efforts in the last decade

Asociación Territorios Vivos El Salvador started the *Ateles* Project in 2013, with a study between May and July at four sites of the Xirihualtique-Jiquilisco Biosphere Reserve: NPA Chaguantique, NA Normandía, El Tercio and Nacascolo, to assess the population abundance and distribution of spider monkeys, and to collect fecal samples for genetic analyses. Abundance was estimated using line transects. To identify how *Ateles* group demographics had changed since the previous studies, we used scan sampling (instantaneous observations of individuals, noting what each visible individual does including sex and age). For line transects, the number of transects walked varied between sites. Transects were approximately 1 km long and were walked at least three times each. Walks were made by four people (2 local park rangers and two researchers) between 6 a.m. and 3:00 p.m.

We counted 107 spider monkeys across the four study sites: 37 males, 49 females, 20 infants and one individual that could not be identified (Table 2). The number of females was higher than males at all sites, except in NA Normandía. A subsequent study at the same sites in 2019, excluding Nacascolo, found almost the same number of individuals at each site, except for Normandía where the number of spider monkeys observed increased from 7 to 26 (Table 2).

Table 1. Summary of abundance, population density and sex ratio of *Ateles geoffroyi* in Chaguantique, El Tercio and Normandía.

Site	Abundance	Population density	Sex Ratio (M:F)	Source
Chaguantique	29 ind.: 64% A, 20% J, 16 % I	82 ind. /km^2	1:7.33 (A) 1:1.5 (J)	Morales-Hernández, 2003
El Tercio	45 ind.: 55% A, 31% J, 14 % I	135 ind. /km^2	1:6.28 (A) 1:4.16 (J)	Morales-Hernández, 2003
Normandía	28 ind.: 57% MA, 25% FA, 4% MJ, 7% FJ, 7% FI	und.	1:0.43 (A)	Argueta-Rivas and Rivera-Hernández, 2004
	21 ind.: 9A y 2J + 7A, 2J, 1I	und.		Rodríguez-Menjívar, 2007

Ind: Individuals, A: Adults, J: Juvenile, I: Infant, und: undetermined, M: Male, F: Female.

Genetic diversity

Through the fecal samples collected within the Xirihualtique-Jiquilisco Biosphere Reserve it was possible to assess the genetic diversity of *Ateles geoffroyi* and genetic-geographic structure (Zaldaña-Orantes et al., 2020). We found that the sampled spider monkeys had lower than expected microsatellite heterozygosity (He= 0.385 - 0.507), and significant genetic differentiation across fragments (Fst = 0.2, P < 0.001) with two genetically distinct groups, in which the groups of NPA Chaguantique, El Tercio and NA Normandía formed one cluster, and the group from El Nacascolo formed another (Zaldaña-Orantes et al., 2020).

Updated Spider monkeys' distribution in El Salvador

In 2017 a population of *Ateles geoffroyi* was rediscovered in the Olomega Lagoon and in 2020 the species was recorded in Cerro El Mono, and NPA El Caballito in Jucuaran mountain range (Pineda et al., 2017, 2020); these populations have not been studied yet (Figure 1).

According to information provided by the Ministry of the Environment and Natural Resources of El Salvador and other organizations, it is possible that the species can also be found in Conchagua, Isla Montecristo (Jiquilisco Bay), and Montecristo National Park (NP), but presence has not been confirmed (Figure 1). Collaborations with the Ministry of the Environment and Natural Resources and other organizations have allowed us to increase the scope of our work, starting more projects for the species, to better understand the status of the species.

Ateles Conservation Program

In 2020 Project *Ateles* became the *Ateles* Conservation Program (ACP), part of the NGO Territorios Vivos El Salvador. This change provided more opportunities to have a positive impact on the species' conservation. As a first step, the ACP has identified priority actions needed to maintain spider monkey populations in El Salvador. One of the first achievements was in leading the elaboration of the National Spider Monkey Conservation Program. This is now an official Program run by the Ministry of Environment and Natural Resources (Diario Oficial, 2022).

The ACP is working together with the Ministry of the Environment and Natural Resources, Paso Pacífico, Fundación Naturaleza, UDP (Unión de Personas or Union of People in English) Ciencias Neotropicales, among others, to generate more information on remnant populations

Table 2. Individuals of *Ateles geoffroyi* observed at each sampling site in Xirihualtique-Jiquilisco Biosphere Reserve. May–July 2013 and February–May 2019.

Site	Males						Female						Inf.		Ind.		**Total**	
	A		SA		J		A		SA		J							
	2013	2019	2013	2019	2013	2019	2013	2019	2013	2019	2013	2019	2013	2019	2013	2019	**2013**	**2019**
CH	7	10	4	0	5	4	20	23	1	0	4	3	10	5	0	5	**51**	**50**
ET	4	4	3	0	1	0	10	35	1	0	2	0	5	4	1	1	**27**	**44**
NA	3	-	4	-	1	-	7	-	2	-	1	-	4	-	0	-	**22**	**-**
NO	4	1	1	0	0	1	1	21	0	0	0	0	1	3	0	0	**7**	**26**
Total	**18**	**15**	**12**	**0**	**7**	**5**	**38**	**79**	**4**	**0**	**7**	**3**	**20**	**12**	**1**	**6**	**107**	**120**

A: Adult; SA: Sub-adult; J: Juvenile; Inf: Infant; Ind: Indeterminate. CH: Chaguantique, ET: El Tercio, NA: Nacascolo, NO: Normandia.

of spider monkeys in the country. The main research challenges are in confirming the species' presence in additional areas of the country where the sampling has been scarce or null (Figure 1). Another urgent need is to estimate spider monkey population densities at different sites, which could be achieved with the use of drone technology, as this method produced more accurate results in other areas of the region (Spaan et al., 2019a). Our densities were calculated from line transect sampling; using different methods could result in different density estimates (Spaan et al., 2019b).

Other conservation priorities include the increased involvement of different sectors of the public, such as children and landowners, in activities that promote habitat conservation for the species. To this end we are beginning a long-term education program as part of our actions.

Brighter future?

As a result of this collaborative work over the last 10 years, we have developed guidelines to carry out conservation actions to help spider monkeys in threatened ecosystems in the country. These actions fall within different subprograms which include: 1) genetics and disease, 2) behavioral research, 3) ecotourism, 4) restoration and connectivity, and 5) environmental education.

Conclusions

After initial sporadic work on spider monkeys in the 2000's, and an increase in effort over the last decade, we now have clearer picture of what needs to be done to ensure the persistence of the species in El Salvador. Now we have strategic plans in research, habitat connectivity, environmental education, and ecotourism. In addition, the ACP team has gained the support of key national organizations (i.e., Ministry of Environment and Natural Resources) and Neotropical primate experts. It is the beginning of a new stage in conservation efforts for the only wild primate in El Salvador.

Acknowledgments

To the Mohamed bin Zayed Species Conservation Fund and Fresno Chaffee Zoo for financial support. We acknowledge Dr. Gustavo Gutiérrez Espeleta and his lab staff M.Sc. Sofía Soto and M.Sc. Genuar Nuñez from the Conservation Genetics Lab at Universidad de Costa Rica. Thanks to Karenina Morales for her technical support in different stages of the ACP. To all the park rangers Arnoldo Luna, Jorge Fernández, Yanira Martinez, José Adán Bonilla, Miguel Ángel Jiménez, Wilber Mejía, Antonio Romero, Ismael Rodríguez ✝ , and Ismael Lozano. To other colleagues Alvin Paz, Carlos Peña, and Kevyn Quijano for their voluntary work in the ACP. Finally, to the Ministry of the Environment and Natural Resources in El Salvador for the research permits and their support.

Luis E. Girón-Galván, Programa de Conservación Ateles El Salvador (PCA) de la Asociación Territorios Vivos El Salvador (ATVES), San Salvador, San Salvador, El Salvador; <luis.giron@atves.org>, **Karla Zaldaña-Orantes**, PCA ATVES, San Salvador, San Salvador, El Salvador; **Lucía Sanchéz-Trejo**, PCA ATVES, San Salvador, San Salvador, El Salvador, and Universidad Dr. José Matías Delgado, Antiguo Cuscatlán, La Libertad, El Salvador; **Elena Castillo**, Ministerio de Medio Ambiente y Recursos Naturales, San Salvador, San Salvador, El Salvador; **Melissa E. Rodríguez**, PCA ATVES, San Salvador, San Salvador, El Salvador.

References

Argueta-Rivas, N. A. and Rivera-Hernández, G. M. 2004. Uso de hábitat del mono araña *Ateles geoffroyi* en el Área Natural Protegida Normandía, Usulután, El Salvador. Undergraduate thesis, Universidad de El Salvador, San Salvador.

Burt, W. H. and Stirton, R. A. 1961. The mammals of El Salvador. In: *Miscellaneous Publications Museum of Zoology* 117: 1–69. University of Michigan, Michigan.

Cortés-Ortíz, L., Solano-Rojas, D., Rosales-Meda, M., Williams-Guillén, K., Méndez-Carvajal, P. G., Marsh, L. K., Canales Espinosa, D. and Mittermeier, R. A. 2021. *Ateles geoffroyi*. The IUCN Red List of Threatened Species 2021. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T2279A191688782.en

Diario Oficial. 2022. Diario Oficial, República de El Salvador en la América Central, miércoles 18 de Mayo de 2022. Tomo N° 435, Número 93. Website: https://www.diariooficial.gob.sv/. Accessed on 22 May 2022.

DiFiore, A. 2009. Genetic Approaches to the study of Dispersal and Kinship in New World Primates. In: *South American Primates (Developments in Primatology: Progress and Prospects)*, P. A. Garber, A. Estrada, J. C. Bicca-Marques, E. W. Heymann and K. Strier (eds.), pp.211–250. Springer, New York.

Hagell, S., Whipple, A. V. and Chambers, C. L. 2013. Population genetic patterns among social groups of the endangered Central American spider monkey (*Ateles geoffroyi*) in a human-dominated landscape. *Ecol. Evol.* 3: 1388–1399.

MARN. 2015. Listado oficial de especies de vida silvestre amenazadas o en peligro de extinción. Website: https://cidoc.ambiente.gob.sv/documentos/acuerdo-257-listado-oficial-de-especies-de-vida-silvestre-amenazadas-y-en-peligro-de-extincion/. Accessed on 22 May 2022.

Medrano, B. and Hernández, J. 2017. Estado actual de las Áreas Naturales Protegidas y Pautas para la Gestión de la Biodiversidad en El Salvador. Unpublished report, Friedrich Ebert Stiftung, San Salvador.

Méndez-Carvajal, P. G., Rodríguez, M. E., Pozo-Montuy, G., Chaves, O. M., Sánchez-Porras, R., Gutiérrez-Pineda, K. M., Spaan, D., Pinel Ramos, E. J. and Zaldaña-Orantes, K. (2022). Geoffroy's Spider Monkey

(Kuhl, 1820), Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, and possibly Colombia. In: *Primates in Peril: The World's 25 Most Endangered Primates 2022-2023*, R. A. Mittermeier, K. E. Reuter, A. B. Rylands, L. Jerusalinsky, C. Schwitzer, K. B. Strier, J. Ratsimbazafy and T. Humle (eds.), pp.134–140. IUCN SSC Primate Specialist Group, International Primatological Society, Re:wild, Washington, DC.

Morales-Hernández, V. K. 2003. Estudio preliminar de la población de *Ateles geoffroyi* "mono araña" en Chaguantique y El Tercio, Departamento de Usulután, El Salvador. Undergraduate thesis. Universidad de El Salvador, San Salvador.

Owen, J. G. and Girón, L. 2012. Revised checklist and distributions of land mammals of El Salvador. *Occasional Papers, Museum of Texas Tech University* 310: 1-32.

Pineda, L. A., Segura, J. H., Medina, K. E., Flores-Márquez, J. and López, M. A. 2017. Redescubrimiento de una población de mono araña (*Ateles geoffroyi*) en la laguna de Olomega, El Salvador. *Acta Zool. Mex*. 33: 532–537.

Pineda, L., Rivera, E. and Guerra, E. 2020. Confirmación de presencia Mono Araña (*Ateles geoffroyi*) en las Montañas de Jucuarán, El Salvador. *Bioma* 55: 6–9.

Rodríguez-Menjívar, M. E. 2007. Monitoreo poblacional de mono araña (*Ateles geoffroyi*) en el área Natural Protegida Normandía, Usulután. Fondo de la Iniciativa para las Américas.

Ruíz-García, M., Parra, A., Romero-Aleán, N., Escobar-Armel, P. and Shostell, J. M. 2006. Genetic characterization and phylogenetic relationships between the *Ateles* species (Atelidae, Primates) by means of DNA microsatellite markers and craniometric data. *Primate Rep*. 73: 3–47.

Rylands, A. B., Groves, C. P., Mittermeier, R. A., Cortés-Ortiz, L. and Hines, J. J. 2006. Taxonomy and distributions of Mesoamerican primates. In: *New Perspectives in the Study of Mesoamerican Primates*, A. Estrada, P. A. Garber, M. S. M. Pavelka and L. Luecke (eds.), pp.29–79.

Spaan, D., Burke, C., McAree, O., Aureli, F., Rangel-Rivera, C. E., Hutschenreiter, A., Longmore, S. N., McWhirter, P. R. and Wich, S. A. 2019a. Thermal Infrared Imaging from Drones offers a Major Advance for Spider Monkey Surveys. *Drones* 3: 34. DOI:10.3390/drones3020034.

Spaan, D., Ramos-Fernández, G., Schaffner, C. M., Smith-Aguilar, S. E., Pinacho-Guendulain, B. and Aureli, F. 2019a. Standardizing methods to estimate population density: an example based on habituated and unhabituated spider monkeys. *Biodivers. Conserv.* 28: 847–862.

Zaldaña-Orantes, K. P., Sánchez-Trejo, L., Girón-Galván, L., Rodríguez, M. E., Nuñez, G. and Gutiérrez-Espeleta, G. 2021. Genetic diversity of the endangered Black-Handed Spider Monkey *Ateles geoffroyi* (Primates:Atelidae) in a fragmented landscape of El Salvador. *Neotrop. Primates* 27: 1–9.

DOI: https://doi.org/10.62015/np.2023.v29.780

INFECÇÃO POR PROTOZOÁRIOS EM PRIMATAS EM PERIGO DE EXTINÇÃO (*ATELES MARGINATUS*) NA AMAZÔNIA MATOGROSSENSE

Samuel Murilo Pagani de Oliveira
Vitória Marinho Clemente
Ian Philippo Tancredi
Julia Moraes Vieira
Gustavo Rodrigues Canale

Resumo

Primatas de vida livre são considerados reservatórios naturais de uma série de parasitos que acometem seres humanos. A infecção de primatas por protozoários pode ocorrer através de ingestão de água contaminada, alimentação à base de pequenos artrópodes, como grilos e baratas, ou mesmo devido a ingestão de solo ou frutas contaminadas. Realizamos a análise de fezes de macacos-aranha-da-cara-branca (*Ateles marginatus*) que ocupam um dos fragmentos florestais (40 ha) que compõem o Parque Natural Municipal Florestal (PNMF), em Sinop – MT. Quarenta e três amostras (43) fecais foram coletadas e processadas pelas técnicas coproparasitológicas de Hoffman (sedimentação) e Willis-Moley (flutuação). Os gêneros de protozoários encontrados em nosso estudo foram *Entamoeba*, *Giardia*, *Cryptosporidium, Isospora* e *Endolimax,* com 23 amostras positivas para a presença de pelo menos um protozoário, e quatro amostras coinfectadas com a presença de dois ou mais protozoários. A presença de coinfecção reforça a prioridade de estabelecer manejos sanitários adequados para a sanidade dos platirrinos em questão, e aponta a necessidade de investigar estas associações entre parasitos. Afinal, muitas dessas moléstias possuem potencial para o transbordamento zoonótico. São necessários mais estudos na região do PNMF a fim de esclarecer detalhadamente a ocorrência, incidência e prevalência de parasitos pois é essencial para traçar o perfil epidemiológico das doenças parasitárias e como as mesmas se comportam, bem como seu risco à saúde humana e à saúde animal.

Palavras-chave: Atelidae, Parasitologia, Protozoa, Zoonoses parasitárias

Abstract

Free-living primates are considered natural reservoirs of a series of parasites that affect humans. Infection of primates by protozoa can occur through ingestion of contaminated water, feeding on small arthropods, such as crickets and cockroaches, or even from the ingestion of contaminated soil or fruit. We carried out fecal analysis of white-faced spider monkeys (*Ateles marginatus*)