

Prevalence of Gastrointestinal Parasites among Captive Primates in Panama

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Abstract: The aim of the present study was determine, the prevalence of the gastrointestinal parasites of wild primates in captivity in the Republic of Panama during the year 2008. During the year 2008 in two Zoos, the summit Municipal Zoo and the Nispero Zoo, there were recollected 87 fecal samples belong to 29, no human clinically healthy individuals of the *Ateles geoffroyi*, *Ateles fuciceps*, *Cebus capucinus*, *Saguinus geoffroyi* and *Aotus lemurinus* species. The samples were processed by the qualitative analysis of concentration by sedimentation using the formol-acetate of ethylic protocol and the modified Zielh-Neelsen's dye. Four genres of major prevalence in primates were identified as: *Cryptosporidium* sp., *Endolimax nana*, *Estrongiloides* sp. and *Entamoeba* sp. The parasite with major prevalence was *Cryptosporidium* sp. in *Ateles fuciceps*. It is important to mention that two PGI have not been reported in Panama, being these: *Oesophagostomum* sp. and *Enteromonas hominis*. The association between the levels of gastrointestinal parasites in both studied zoos, was evaluated using Fisher's exact test and the results indicated that there exists no significant difference between them and the level of significance of $p < 0.05$. This is Panama's first record of the species of gastrointestinal parasites that affects the animals in captivity therefore, this research will serve as a guide to establish the necessary preventive measures to favor the conservation of these species.

Key words: Gastrointestinal parasites, captivity primates, parasites, prevalence, Panama

INTRODUCTION

There are few studies that report qualitative and quantitative information about the non human primate parasites kept in captivity. From the ecological point of view, the parasites can provide specific information about the type of nutrition of the host and can also be ecological indicators to detect changes in species' diversity, useful information to monitor their health and the ecosystem (Carrasco *et al.*, 2008).

According to Chinchilla *et al.* (2005), the existence of the reserved areas have contributed to the conservation

of primates, while the destruction of the habitat and the illegal hunting are almost always the responsible factor the decreasing number of individuals in the wild population, although, we can not ignore the parasite infections, especially if it is taken into account that each day exists greater contact between wild and domestic animals and the human beings.

All of these aspects have caused the need to establish conservation rules for the wild animals and the most used ones are to keep them in public and private protected areas and in captivity in zoos or similar areas.

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The first symptoms of parasitic disease are dyspnea, diarrhea and anorexy, which are associated with behavioral changes caused by the lost of vigor of the parasite individual, this last aspect influences in a negative way his ability to protect the area and select a couple (Biagi, 2004; Gallego, 2007; Mehlhorn and Piekarski, 1993; Suzan *et al.*, 2000).

The diseases that sporadically appear in captivity animals show that there must be a constant sanitary monitoring in order to identify and describe the parasites that are in wild mammals in captivity and Panama is not exempted from doing it, because they can shelter zoonotic diseases with difficult effects to determine.

Panama doesn't have and record about the gastrointestinal parasites species that affect animals in captivity nor its prevalence therefore, this research will serve a guide to establish preventive measures necessary for its conservation.

For this reason, one of the objectives of this research is to determine the prevalence of the gastrointestinal parasitoses of wild primates in captivity in Panama and the other objective is to compare the results of gastrointestinal parasitoses in the two studied zoos.

MATERIALS AND METHODS

Study areas: Two zoos were selected, the summit Municipal Park (belongs to the state) located 15 min from Panama city and El Nispero (Private), located in Anton, province of Coclé, at 3 h from Panama city.

Summit municipal park: It is a botanic garden and a Zoo of 250 ha of total extension, located in the outskirts from Panama City. The weather of the region is subhumid tropical with rain during the summer; of Köppen Awoing's climatic classification modified by Kottek *et al.* (2006). The highest environmental temperature varies from 35-40°C and the average of environmental temperature is of 27°C. The relative humidity varies from 65-90%, with an average of 80% and a yearly fluvial rainfall of 935.5 mm. There are 2 yearly seasons: the rainy season (from May-November) and the dry (from December-April).

El-Nispero zoo: El Nispero is a private zoo, located in the Valle de Anton, province of Coclé. It has 89 different species of animals and about 180 different kinds of trees and plants. The average annual temperature is of 20°C/70°F. There are two seasons: rainy (from May-November) and the dry (from December-April).

Copro-parasitologic analysis: During the year 2008, 29 primates, non human, clinically healthy were evaluated and distributed in the following way: 21 from the Summit

Zoo, being these *A. Geoffroyi* (Red Spider Monkey), *A. fusciceps* (Black Spider Monkey), *C. capucinus* (White-face Monkey), *S. Geoffroyi* (Titi Monkey) and *A. lemurinus* (Night Monkey) and 9 corresponding to El Nispero: *A. fusciceps* (Black Spider Monkey), *C. capucinus* (White-face Monkey) and *S. Geoffroyi* (Titi Monkey).

In total, there were collected 87 samples of faeces (63 from the Summit and 24 from El Nispero), during the dry season, transition and the rainy season. The day of the recollection, each sample was preserved with three volumes of formalin at 10% before taking then to the laboratory. The preserved samples were microscopically analysed in the search of parasites through a concentration by sedimentation formol-acetate of ethylic (Bowman and Carl, 2002) and by the Kinyoun's dye for intestinal coccidian (De La Ossa *et al.*, 2007; Galvan *et al.*, 2008).

During the sampling period, there were obtained climatologically data, monthly averages of the weather station of El Valle de Anton and of the weather station of Albrook, both of the ETESA Company. The registered variables were the gastrointestinal prevalence, the average environmental temperature and the fluvial rainfall, in addition there were contrasted the prevalence of gastrointestinal parasites among the studied zoos, using the Fisher's exact test.

RESULTS AND DISCUSSION

Table 1 shows the gastrointestinal parasites found in primates of two zoos of Panama, where the results show that the general prevalence increased from the dry season to the rainy season, from 30-93%. This can be, due to the environmental conditions (high temperatures and precipitation) that are presented in Panama during the rainy season and that benefit the development of the different evolutive forms of the gastrointestinal parasites.

The trustworthy intervals show the 95% (Table 1), should be: for 9/30 = 30%. The intervals is from 12.3-49.4%; for 5/29 = 17.2%, the interval is from 5.2-35.8% and for 27/29 = 93.1%, the interval is from 33.9-99.2%; as it shows, there are overlaps in the intervals for the different seasons therefore, we can't affirm that there are significant differences in the population however, there are important differences in the percentages, the intervals don't affirm that the differences are attributable to the different seasons, especially because it was disposed from a small sample.

According to Chinchilla *et al.* (2007), the high infection in the monkeys could be related with their behavior and the variety in their alimentary diet, since they are fed with a great variety of fruits and of stored up water in the holes of trees or from the ground were

Table 1: The prevalence of gastrointestinal parasites in wild primates in two zoos in Panama, in the year 2008

Species	Common name	Infec./exam (%)		
		Dry season	Transition	Rainy season
Primates				
<i>Ateles geoffroyi</i>	Red spider monkey	0/1	1/1	1/1
<i>Ateles fusciceps</i>	Black spider monkey	6/9	0/9	8/9
<i>Cebus capucinus</i>	White-face monkey	0/10	4/10	6/10
<i>Saguinus geoffroyi</i>	Titi monkey	3/9	0/9	6/9
<i>Aotus lemurinus</i>	Night monkey	0/1	0*	0*
Total	-	9/30 (30%)	5/29(17%)	7/29(93%)

Table 2: Prevalence of gastrointestinal parasites in wild primates in the Summit municipal zoo and el Nispero, Panama 2008

Species	Common name	Infec./exam. (%)		
		Dry season	Transition	Rainy season
Primates (Summit zoo)				
<i>Ateles geoffroyi</i>	Red spider monkey	0/1	1/1	1/1
<i>Ateles fusciceps</i>	Black spider monkey	5/8	0/8	7/8
<i>Cebus capucinus</i>	White-face monkey	0/9	4/9	5/9
<i>Saguinus geoffroyi</i>	Titi monkey	1/2	0/2	2/2
<i>Aotus lemurinus</i>	Night monkey	0/1	0*	0*
Total	-	6/21 (28%)	5/20(25%)	15/20(75%)
Primates (El-Nispero zoo)				
<i>Ateles fusciceps</i>	Black spider monkey	1/1	0/1	1/1
<i>Cebus capucinus</i>	White-face monkey	0/1	0/1	1/1
<i>Saguinus geoffroyi</i>	Titi monkey	2/7	0/7	4/7
Total	-	3/9 (33%)	0/9 (0)	6/9(66%)

*The Night monkey died before doing the second sampling

they swallow more contaminated food. Another factor that could have influenced the contact between these animals and the human beings, is that they receive food from tourists and according to Stuart and Strier (1995) this behavior increased the possibility of the transmission of parasites, in addition; social character of the non-human primates facilitates the processes of parasite transmission among them thus, according to Chinchilla *et al.* (2007), the infection of females and males is practically the same, which don't represent important data.

In Table 2, you can observe that the Summit Zoo primates presented a high prevalence of gastrointestinal parasitoses during the rainy season, being of 75%, while El-Nispero Zoo primates presented a prevalence of 66% during the rainy season.

These results may coincide with the studies of Polo *et al.* (2007), who suggest that the parasitic diseases have a high incidence in the zoos of countries of warm and tropical climates due to the factors that favor the development of parasites such as light, temperature and humidity.

Also, Fisher's exact test was used to compare the prevalence of gastrointestinal parasites in the two zoos, where with a significance level of $p < 0.05$ and because, the probability is > 0.05 or 0.28, it is concluded that there are no significant differences between the prevalence of parasitoses and the seasons of the year.

The trustworthy intervals at the 95% (Table 2) for the prevalences at the Summit Zoo are as follows; for 6/21 = 28%, the range is from 9.25-52.2% for 5/20 = 25%, the range is from 7.22-49.1% and 15/20 = 75%, the range is from 29.6-91.3%, so it can't be affirmed that there are significant differences between the parasitoses prevalences and the seasons.

Furthermore, also in Table 2; the confidence intervals of 95% for the prevalence in El-Nispero zoo are: For 3/9 = 33%, the range is from 5.6-70 and 6/9 = 66%, the range is from 17.1-92.5%, indicating that it cannot be said there are significant differences between seasons, but significant percentage results are presented.

In Table 3, it is a presentation of the gastrointestinal parasites identified in the non-human primates, in the Summit and El-Nispero zoos. We found the following species: *Cryptosporidium* sp., *Strongyloides* sp., *Entamoeba* sp., *Giardia* sp., *Necator* sp., *Oesophagostomun* sp., *E. nana* and *E. hominis*. Other authors such as Munene *et al.* (1998) and Muriuki *et al.* (1998), also working with non-human primates living in Africa, found the same parasites *Strongyloide* sp., *E. coli*, *E. histolytica*, *B. coli* and *Cryptosporidium* sp. and others that were not found in this study, then to draw the attention to the potential transmissibility of some of these species to humans.

The record of the following parasites, *Cryptosporidium* sp., *E. nana* and *E. hominis* in primates

Table 3: Seasonal distribution of the prevalence of gastrointestinal parasitoses in wild primates in two zoos in Panama, 2008

Species of parasites in primates	Dry season				Transition				Rainy season			
	Summit		Nispero		Summit		Nispero		Summit		Nispero	
	P	%	P	%	P	%	P	%	P	%	P	%
<i>Cryptosporidium</i> sp.	4	19	0	0	3	14	0	0	0	0	0	0
<i>Strongyloides</i> sp.	0	0	1	11	2	9	0	0	6	28	4	44
<i>Entamoeba coli</i>	0	0	1	11	0	0	0	0	8	38	3	33
<i>Entamoeba</i> sp.	0	0	1	11	0	0	0	0	0	0	0	0
<i>Giardia</i> sp.	2	9	0	0	0	0	0	0	4	19	2	22
<i>Necator</i> sp.	1	4	0	0	0	0	0	0	7	33	5	55
<i>Oesophagostomun</i> sp.	1	4	0	0	0	0	0	0	0	0	0	0
<i>Endolimax nana</i>	3	14	0	0	0	0	0	0	1	3	0	0
<i>Enteromonas hominis</i>	1	4	0	0	0	0	0	0	0	0	0	0

P: Parasites prevalence, %: Parasites prevalence, Summit, N₁: Analyzed animals: 21, El-Nispero, N₂: Analyzed animals: 9

analyzed in this study is important, because it is possible to be transmitted to professionals such as veterinarians, biologist and treathurs who work with these animals.

During 2008, the greatest gastrointestinal prevalence in non-human primates during the dry season, was presented by, *Cryptosporidium* sp. and *E. nana* by 19 and 14%, respectively. It was further noted that during the transition period the overall prevalence decreased, but it increased during the rainy season, finding high presence of *Strongyloides* sp. (28 and 44%), *E. coli* (38 and 33%), *Giardia* sp. (19 and 22%) and *Necator* sp. (33 and 55%), respectively in both zoos.

Cryptosporidium sp., is the most prevalence protozoa found in 19% of the primates examined, during the dry season, In a study, conducted in Argentina by Venturini *et al.* (2006), *Cryptosporidium* sp. it was also, the most abundant parasite found and was found in the 100% of the studied primates. The animals sampled at both zoos had no symptoms because the parasite usually lives for long periods in the host, inducing a prolonged antigenic stimulation with activation of a large number of immune mechanisms.

The coccidians, as the *Cryptosporidium* sp are unicellular apicomplex typical of intracellular location that reproduce sexually and asexually eliminating immature oocysts through fecal materials, which contaminate food and water where, they are deposited, which can make its permanence cyclical in animals in captivity. In most cases, the coccidian infections are subclinical but eventual diarrhea related to nutrition, health state and stress in mammals can occur.

The results of this study agree with those found in other research works done in wild mammals, where protozoa was identified as *Cryptosporidium* sp., *Strongyloides* sp., *E. coli*, *Entamoeba* sp., *Giardia* sp., *Oesophagostomun* sp. and *Necator* sp. (Arroyo, 2002; Figueiroa *et al.*, 2001; Karere and Munene, 2002; Munene *et al.*, 1998).

The presence of parasitic infections is more common in animals in captivity than in free-living because they

are kept constantly in a contaminated environment with parasites and especially monoxenos as posed Figueiroa *et al.* (2001), which explains that in a captive environment, is inevitable exposure of mammals to potentially pathogenic microorganisms as posed Munene *et al.* (1998).

The record of parasitism is important, because, according to Chapman *et al.* (2005), these parasites can cause the death of primates for the following reasons: Inflammation of the mucosa, severe diarrhea, weight loss, enteritis and hepatitis among others.

The records of parasitism in non-human primates of the following genres *Cryptosporidium* sp., *E. coli*, *Entamoeba* sp., *Necator* sp., *Oesophagostomun* sp., *E. nana* and *E. hominis* is of zoonotic importance. From the nine PGI reported genres in primates, seven has been previously identified in primates of the neotropical area in other countries as in this research (Arroyo, 2002; Chinchilla *et al.*, 2005; Polo *et al.*, 2007; Venturini *et al.*, 2006), however, it is important to mention that two has not been reported in primates of Panama, which are *Oesophagostomun* sp. and *E. hominis*.

It is important to mention that it was as exploratory and descriptive study of great significance, because there is little information or no information in Panama on the different types of gastrointestinal parasites that effect populations of wild animals in captivity. It is important too, the environmental conditions and management practices in zoos, such as food, cleanliness, overcrowding and deworming among others may influence the prevalence of parasitic infections, a subject of paramount importance to initiate conservation programs exsitu of wild animals.

CONCLUSION

Four types of gastrointestinal parasites were identified, which are most prevalent: *Cryptosporidium* sp., *E. nana*, *Estrongyloides* sp. and *Entamoeba* sp. In healthy non-human primates of *Ateles geoffroyi*, *Ateles*

fusciceps, *Cebus capucinus*, *Saguinus Geoffroyi* and *Aotus lemurinus* species. The most prevalent parasite in primates was *Cryptosporidium* sp. in *A. fusciceps*.

Two gastrointestinal parasites have not been reported in primates in Panama, been these: the *Oesophagostomum* sp. and *Enteromonas hominis*.

There are no significant differences, when comparing the prevalence of gastrointestinal parasites in the Summit (belongs to the state) and El-Nispero (Private), according to the Fisher's Exact Test.

In Panama, there are no records on the species of gastrointestinal parasites affecting animals in captivity and their prevalence; it is considered that this research is the first international report.

This research will establish the necessary preventive measures to reduce and eliminate the presence of parasites in primates, in order to benefit their conservation.

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REFERENCES

Arroyo, L., 2002. Parasites of wild animals in captivity in Lima, Peru. J. Bio. Peru., 9 (2): 118-120. http://sisbib.unmsm.edu.pe/Bvrevistas/biologia/v09_n2/PDFs/Parasitos.pdf.

Biagi, F., 2004. Parasitic Diseases. 3rd Edn. In: El-Manual Moderno (Ed.). S.A. de C.V. Mexico, pp: 402. ISBN: 970-729-070-6.

Bowman, D. and R. Carl, 2002. Georgi's Parasitology for Veterinarians. 7th Edn. WB Saunders Company, Philadelphia, EU, pp: 144-357. ISBN: 0721670970. DNLMDLC 9817175.

De La Ossa, M., N., A. Falconar, Llinas Solano and C. Romero, 2007. Clinical manifestations and risk factors associated with *Cryptosporidium* sp. infections in patients from Barranquilla and three municipios of Atlantico (Colombia). J. Heal. Uni. Barranquilla, 23 (1): 19-31. http://www.scielo.org.co/scielo.php?pid=S0120-55522007000100004&script=sci_arttext.

Carrasco, F., M. Tantalean, K.N. Gibson and M. Williams, 2008. Prevalence of intestinal helminths in a population of wild monkeys spider monkey Ateles belzbuti chamek National Park in Manu, Peru. Neotrop. Helminthol., 2 (1): 19-26. <http://sisbib.unmsm.edu.pe/BVRevistas/neohel/v2n1/pdf/a03.pdf>.

Chapman, C., T. Gillespie and T. Goldberg, 2005. Primates and the ecology of their infectious diseases: How will anthropogenic change affect host-parasite interactions. J. Evol. Anthropol., 14: 134-144. DOI: 10.1002/evan.20068. <http://www.vetmed.wisc.edu/goldberglab/pdf/P026.pdf>.

Chinchilla, M., O. Guerrero, G. Gutierrez-Espeleta, R. Sanchez and V. Campos, 2007. Parasites faced *Cebus capucinus* monkeys (Primates: Cebidae) of Costa Rica. *Parasitol latinoam*, 62 (3-4). DOI: 10.4067/S0717-77122007000200011. http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0717-77122007000200011&lng=es&nrm=iso&tng=es.

Chinchilla, M., O. Guerrero, G. Gutierrez, R. Sanchez and B. Rodriguez, 2005. Intestinal parasites in monkeys congo *Alouatta palliata* (Primates: Cebidae) in Costa Rica. Int. J. Trop. Biol., 53 (3-4): 437-445. http://www.scielo.sa.cr/scielo.php?script=sci_arttext&pid=S0034-77442005001200012&lng=e&nrm=iso#ro04.

Figueiroa, M., B. De Oliveira, A. Dowell and M. Cavalcanti, 2001. Profile coproparasitologic of wild mammals in captivity in the state of Pernambuco, Brasil. J. Parasitol. Dia., 25 (3-4): DOI: 10.4067/S0716-07202001000300009. http://www.scielo.cl/scielo.php?pid=S0716-07202001000300009&script=sci_arttext.

Galvan, A., V. Herrera, Z. Santos and M. Delgado, 2008. Ziehl-Neelsen stainings Safranin and modified for the Diagnosis of *Cyclospora cayetanensis*. J. Pub. Health, 10 (3): 488-493. Bogota, Colombia. DOI: 10.1590/S0124-00642008000300014. <http://www.scielo.org/pdf/rsap/v10n3/v10n3a14.pdf>.

- Gallego, J., 2007. Manual of Parasitology. Morphology and Biology of Parasites of Medical Interest. 2nd Edn. Publicacions i Edicions. University of Barcelona. España, pp: 88-94. ISBN: 9788447531417. http://books.google.com.pa/books?id=XH4yn_OANn4C&pg=PA50&lpg=PA50&dq=medio+ambiente+y+los+par%C3%A1sitos&source=web&ots=TcrQsvIXUX&sig=fzBKI22JO7SrC-s7qA4eHyqFizchl=es#PPA50,M1.
- Karere, G. and E. Munene, 2002. Some-gastrointestinal tract parasites in wild Brazza's Monkeys (*Cercopithecus neglectus*) in Kenya. J. Vet. Par., 110: 153-157. DOI: 10.1016/S0304-4017(02)00348-5. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TD7-473N387-B&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=984194361&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=4513b8df2d969a7681fd71514e53d811.
- Kottek, M., J. Grieser, C. Beck, B. Rudolf and F. Rubel, 2006. World Map of the Koppen-Geiger climate classification updated. J. Met. Z., 15: 259-263. DOI: 10.1127/0941-2948/2006/0130. <http://koeppen-geiger.vu-wien.ac.at/>.
- Mehlhorn, H. and G. Piekarski, 1993. Foundations of Parasitology: Parasites of man and domestic animals. Ed. Acribia, Zaragoza. ISBN: 8420007382.
- Munene, E., A. Otsyula and D. Mbaabu, 1998. Helminth and protozoan gastrointestinal tract parasites captive and wild-trapped African non-human primates. J. Vet. Par., 78: 195-201. DOI: 10.1016/S0304-4017(98)00143-5. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TD7-3THYGRH-4&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=984203628&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=1678508d67009426a783d2cbd0e10d31.
- Muriuki, S., R. Murugu, E. Munene, G. Karere and D. Chai, 1998. Some gastro-intestinal parasites of zoonotic (public health) importance commonly observed in old world non-human primates in Kenya. Acta Tropica, 71 (1): 73-82. DOI: 10.1016/S0001-706X(98)00040-0. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T1R-3TKM7TY-6&_user=10&_coverDate=08%2F15%2F1998&_rdoc=1&_fmt=high&_orig=browse&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=8fd8cc51e2a8c3ba89012b18c50eff.
- Polo, L., M. Payan, C. Prado, O. Quiala, A. Ponce and B. Zulaeta, 2007. Major intestinal parasites (nematodes) diagnosed affecting the chimpanzee (*Pan troglodytes troglodytes*) of the National Zoological Park in Cuba. Elec. J. Vet., 8 (3): 1-11. <http://www.veterinaria.org/revistas/redvet/n030307.html>.
- Stuart, M. and K. Strier, 1995. Parasites and primates: A case for a multidisciplinary approach. Int. J. Primatol., 15 (5): 577-593. DOI: 10.1007/BF02735282.
- Suzan, G., F. Galindo and G. Ceballos, 2000. The Importance of the study of diseases in wildlife conservation. J. Vet. Mex., 31 (3). <http://www.ejournal.unam.mx/rvm/vol31-03/RVM31308.pdf>.
- Venturini, L., D. Basigalupe, W. Basso, J.M. Unzaga, M.C. Venturini and G. More, 2006. *Cryptosporidium parvum* in domestic animals and monkeys in a zoo. Parasitol. Lat., 61: 90-93. <http://74.125.45.104/search?q=cache:LA2x0NDGdJII:www.scielo.cl/pdf/parasitol/v61n1-2/art14.pdf+Criptosporidium+sp+en+monos&hl=es&ct=clnk&cd=2&gl=pa>.