Predation attacks on wild spider monkeys (*Ateles geoffroyi*)

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word number: 2469

Abstract

We report two cases of predation on an adult and a subadult spider monkey (*Ateles geoffroyi*) by a puma (*Puma concolor*) and an unidentified terrestrial predator at the natural protected area of *Otoch Ma'ax yetel Kooh*, in the Yucatan peninsula, Mexico. Although spider monkeys are believed to experience overall low predation pressure compared to other primate species, our observations show that predation occurs in the study area and therefore behavioral strategies are likely to be in place to reduce predation risk. Our observations are further evidence that terrestrial predators are a threat for both young and full-grown spider monkeys.

Keywords: *Ateles*, terrestrial predators, fission-fusion dynamics, predation pressure, intra-group aggression, long-term research project

Introduction

Predation avoidance is known as one of the main ecological forces favoring group living [van Schaik, 1983; Pulliam and Caraco, 1984; Isbell 1994]. In larger groups, the probability of being preyed upon is lower due to the dilution and confusion effects, increased vigilance, and the ability to mob predators [Pulliam, 1973; Elgar, 1988]. Predation avoidance not only favors the formation of stable groups, but also affects subgrouping patterns in species with a high degree of fission-fusion dynamics [e.g., Heithaus and Dill, 2002; Link and Di Fiore, 2013], in which individuals form subgroups variable in size and composition [Aureli et al., 2008]. Some studies demonstrate an increase in subgroup size [e.g., bottlenose dolphins, *Tursiops truncatus*, Heithaus and Dill, 2002; white-bellied spider monkeys, *Ateles belzebuth*, Link and Di Fiore, 2013] or in the number of males in subgroups [e.g., chimpanzees, *Pan troglodytes*, Boesch, 1991] when the perception of predation risk is high. Primate species emit specific vocalizations, or "alarm calls", with the double function of alerting conspecifics of a predator's presence and of signaling to the predator that it has been spotted [Zuberbühler et al, 1999].

Spider monkeys are characterized by a high degree of fission-fusion dynamics [Symington, 1990, Aureli and Schaffner, 2008]. Given their large body size, their predominant use of the forest upper canopy and that they form relatively small sub-groups, spider monkeys are considered to be less susceptible to predation compared to other primate species [Symington, 1987; Di Fiore, 2002]. However, a lower susceptibility does not mean spider monkeys are free from predation. Indeed, reports of spider monkey predation are published for South American sites [see Di Fiore, 2002 for a list of observed and suspected cases]. To date spider monkey predators include: pumas

[*Puma concolor*, Matsuda and Izawa, 2008], jaguars [*Panthera onca*, Matsuda and Izawa, 2008], crested eagles [*Morphus guianensis*, Julliot, 1994], and possibly harpy eagles [*Harpia harpyja*, Sherman, 1991; Julliot, 1994], confirming that the main primate predators in the Neotropics are raptors and felids (Hart, 2012). Spider monkeys use the short and repetitive "bark vocalization" as an alarm call [Einseberg and Kuehn, 1966], which is further evidence that they are vulnerable to predation.

Here, we report the first two observations of predation on Geoffroy's spider monkeys (*Ateles geoffroyi*). Both predation attacks resulted in the death of the monkey.

Method

Study site and subjects

Observations reported here occurred in the *Otoch Ma'ax yetel Kooh* protected area, Yucatan Peninsula, Mexico (20°38' N, 87°38' W), adjacent to the village of Punta Laguna. The protected area covers 5367 ha, and includes a mosaic of old-growth, semi-evergreen medium forest, with trees up to 25 m in height, and 30–50-year-old successional forest [Ramos-Fernandez and Ayala-Orozco, 2003]. In the protected area terrestrial predators, such as pumas and jaguars, could prey upon spider monkeys, but there are no reports of potential aerial predators [CONANP, 2006].

Study subjects were members of two groups ("E" and "W") of wild spider monkeys (*Ateles geoffroyi*), which have been continuously studied since 1997 [Ramos-Fernandez et al., 2018]. Over the years, group size in each group varied from 14-51 (E), and 18 to 43 (W) [Ramos-Fernandez et al., 2018].

Results

Case 1: Unidentified predator attack

On February 2, 1997, at 07:50, upon disembarking from a canoe near the western shore of the Punta Laguna lake (2km across, 20°39'10.3"N 87°39'01.1"W), GRF and a field assistant saw a subgroup of spider monkeys moving north. Immediately after this, the observers heard bark vocalizations coming from the southern direction, from a different subgroup of spider monkeys. When approaching, 3 monkeys, including an adult female, were alarm-calling. The monkeys had likely spent the night there, as there were fresh feces accumulated under a large tree. On the ground, the observers found traces of fresh blood, some of which appeared smeared as if left by a bleeding animal being dragged away. The observers followed these traces for about 100m in a southern direction, until they found an adult female spider monkey lying dead on the ground. The corpse had an incomplete skull and brain, and a chest injury near the right arm. While sitting 20m away from the dead body, the observers heard movement sounds coming from the area around the dead monkey. The observers waited for approximately 30 min, but no animal was seen approaching it. They then photographed and weighed the corpse (6kg; Figure 1a).

Case 2: Puma predation attack

On June 18, 2013, LB and two field assistants followed a subgroup of at least 7 adult females and their respective juvenile and infant offspring, who started to travel from their sleeping trees at 06:28. At 06:38 two adult females and two juveniles began to attack an unfamiliar subadult female just encountered by the subgroup. At least 3 times the subadult female approached the ground as a consequence of being attacked. At 06:43, observers heard a sound like a heavy piece of wood hitting the ground, coming from the tree where the subadult female was seen. All members of the subgroup started to produce alarm calls. A field assistant arrived at the location where the sound

originated and saw a puma running away [the species identification was confirmed by the footprints using the key in Bowers et al., 2007]. Soon after, the observers discovered the subadult female on the ground with severe head injuries including an exposed piece of brain close to the left ear (Figure 1b). The subadult female was slowly moving her head and legs, producing soft vocalizations. The other monkeys stopped alarm calling around 07:20 and remained in the same location, resting quietly and producing only three whinnies (i.e. contact calls: Ramos-Fernandez, 2005] at 07:37, 07:58 and 08:04. The observers sat 20 m away from the monkey to wait for the puma to take its prey, but no animal appeared and no noise was heard. Between 09:00 and 09:20 all the other monkeys moved away so silently that observers did not realize when they left. The injured monkey was still alive, but eventually died.

Discussion

Our observations constitute further evidence that terrestrial predators are a threat for adult and subadult spider monkeys. The low frequency of observations of predation can be attributed to three main factors. First, spider monkeys face a low predation risk [Symington, 1987; Di Fiore, 2002]. The low predation pressure results in a low perception of predation risk by individuals [cf. Hill and Lee, 1998], which allows them to form small subgroups [mean subgroup size: 3-5 individuals, Chapman et al., 1995; Ramos-Fernandez and Ayala-Orozco, 2003]. Second, predator behavior can be elusive [Isbell, 1994]. If the predators' elusive behavior is partially related to their not being habituated to human presence, predation events can be less frequent in areas with higher human presence and on studied rather than unstudied primate groups [Isbell and Young, 1993]. Third, predation can occur even if rarely observed by researchers given that Neotropical primate

skeletal remains are regularly found in puma and jaguar feces [e.g., Emmons, 1987; Chinchilla, 1997].

In Case 2, an aggressive interaction occurred in the minutes prior to the predation attack on the unfamiliar subadult female. Aggressive interactions from resident females to recently immigrated females are not uncommon events in spider monkeys [Asensio et al., 2008; Slater et al., 2009; Riveros et al., 2017]. Descending toward the ground, as the subadult female did, is a common response by spider monkeys to avoid aggressive interactions [Campbell et al., 2005]. The predation attack presumably occurred when the subadult female was at a relatively low height. For a species living mainly in the forest upper canopy, the ground is likely perceived as an area of high predation risk [Link and Di Fiore, 2013]. If terrestrial predators are in the same area when aggressive interactions occur, they may take advantage of spider monkeys' tendency to escape aggressors by moving toward the ground, as we observed.

There are many benefits of long-term field investigations on habituated primate groups [Kappeler and Watts, 2012]. One of these is the possibility of observing relatively rare events. During our 20-year project we have documented rare events such as raids [Aureli et al., 2006], within-group coalitionary killing [Valero et al. 2006], and homosexual behavior [Busia et al., 2018]. Our observations of two predation events in over 20 years represent further evidence that predation rate in spider monkey can be extremely low, but also that terrestrial predators represent a threat to spider monkeys of all age classes. These are important contributions to the appreciation of the role of predation in spider monkey behavior. In addition to research on predator's diet [Hart, 2007], the use of camera traps and/or radio-collars on predators would make primate researchers aware of predator ranging behavior and would help them better understand

the role of predation in driving behavior (e.g., degree of fission-fusion dynamics, ranging) of primates experiencing low predation pressure, such as spider monkeys. .

Additional note

On May 14 2018, a local villager found a dead adult female spider monkey within the home range of the studied monkey community. The monkey had been dead for a few days and part of its head was missing. Although the head injury could have been inflicted by a large cat, as in the events we report, we had no other evidence to infer a third predation event.

Acknowledgements

We thank Augusto Canul, Eulogio Canul, Juan Canul and Macedonio Canul for their valuable assistance during fieldwork. We are grateful to Laura G. Vick for sharing the management of the long-term project. We thank the Instituto Politecnico Nacional and the Consejo Nacional de Ciencia y Tecnología (CONACyT) for LB's and SS's PhD studentships (CVU n° 490429 and CVU n° 220315, respectively) and for equipment (n° I0101/152/2014 C-133/2014). We thank Lara Grieder, Anna Nekaris and two anonymous reviewers for useful comments on a previous version of the manuscript. We conducted our research in accordance with the guidelines of the Department of Environment and Natural Resources of Mexico (SEMARNAT) and the Mexican Commission for Protected Areas (CONANP) under research permits DGVS00910/13 and DGVS02716/14.

References

Asensio N, Korstjens AH, Schaffner CM, Aureli F (2008). Intragroup aggression,

fission fusion dynamics and feeding competition in spider monkeys. *Behaviour* 145: 983-1001.

Aureli F, Schaffner CM (2008). Social interactions, social relationships and the social system of spider monkeys. In: *Spider monkeys*: *Behavior, ecology and evolution of the genus Ateles (*Campbell CJ ed.), pp. 236-265. Cambridge, Cambridge University Press.

Aureli F, Schaffner CM, Verpooten J, Slater K, Ramos-Fernandez G (2006). Raiding parties of male spider monkeys: insights into human warfare *American Journal of Physical Anthropology* 13: 486-497.

Aureli F, Schaffner CM, Boesch C, Bearder SK, Call J, Chapman CA, Connor R, Di Fiore A, Dunbar RIM, Henzi SP, Holekamp K, Korstjens AH, Layton R., Lee P, Lehmann J, Manson JH, Ramos-Fernandez G, Strier KB, van Schaik CP (2008). Fission-fusion dynamics: new research frameworks. *Current Anthropology* 49: 627-654.

Boesch C (1991). The effect of leopard predation on grouping patterns in forest chimpanzees. *Behaviour* 117: 220-242.

Bowers N, Bowers R, Kaufman K (2007). *Kaufman Field Guide of Mammals of North America*. Boston, Houghton Mifflin.

Busia L, Denice AR, Aureli F, Schaffner CM (2018) Homosexual behavior between male spider monkeys (*Ateles geoffroyi*). *Archives of Sexual Behavior* 47: 857-861.

Campbell CJ, Aureli F, Chapman CA, Ramos-Fernández G, Matthews K, Russo SE, Suarez S, Vick L (2005). Terrestrial behavior of *Ateles* spp. *International Journal of Primatology* 26: 1039-1051.

Chapman CA, Wrangham RW, Chapman LJ (1995). Ecological constraints on group size: an analysis of spider monkey and chimpanzee subgroups. *Behavioral Ecology and Sociobiology* 36: 59-70.

Chinchilla FA (1997). La dieta del jaguar (*Panthera onca*), el puma (*Felis concolor*) y el manigordo (*Felis pardalis*) (Carnivora; Felidae) en el Parque Nacional Corcovado, Costa Rica. *Revista de Biología Tropical* 45: 1223-1230.

CONANP (2006). Programa de conservación y manejo – área de protección de flora y fauna Otoch Ma'ax Yetel Kooh, México, Mexico, Comisión Nacional de Áreas Naturales Protegidas.

Di Fiore A (2002). Predator sensitive foraging in ateline primates. In: *Eat or be eaten: Predator sensitive foraging among primates (*Miller LE ed.), pp. 242-267. New York, Cambridge University Press.

Eisenberg JF, Kuehn RE (1966). The behavior of *Ateles geoffroyi* and related species. *Smithsonian Miscellaneous Collection* 151:1-63.

Elgar MA (1988). Predator vigilance and group size in mammals and birds: a critical

279 review of the empirical evidence. *Biological Reviews of the Cambridge Philosophical*
280 *Society* 64:13-33.
281
282 Emmons LH (1987). Comparative feeding ecology of felids in a neotropical
283 rainforest. *Behavioral Ecology and Sociobiology* 20*:* 271-283.
284
285 Hart D (2007). Predation on primates: a biogeographical analysis. In *Primate*
286 *Anti-predator Strategies* (Gursky-Doyen S, Nekaris KAI eds.), pp. 27-59. Boston,
287 Springer.
288
289 Heithaus MR, Dill LM (2002). Food availability and tiger shark predation risk influence
290 bottlenose dolphin habitat use. *Ecology* 83: 480-491.
291
292 Hill RA, Lee PC (1998). Predation risk as an influence on group size in cercopithecoid
293 primates: implications for social structure. *Journal of Zoology* 245: 447-456.
294
295 Isbell LA (1994). Predation on primates: ecological patterns and evolutionary
296 consequences. *Evolutionary Anthropology: Issues, News, and Reviews* 3: 61-71.
297
298 Isbell LA, Young TP (1993). Human presence reduces predation in a free-ranging
299 vervet monkey population in Kenya. *Animal Behaviour* 45: 1233-1235.
300
301 Kappeler PM, Watts DP (2012). *Long-term Field Studies of Primates*. Berlin,
302 Springer Science & Business Media.
303

Julliot C (1994). Predation of a young spider monkey (*Ateles paniscus*) by a crested eagle (*Morphnus guianensis*). *Folia Primatologica* 63: 75-77.

Link A, Di Fiore A (2013). Effects of predation risk on the grouping patterns of white-bellied spider monkeys (*Ateles belzebuth belzebuth*) in western Amazonia. *American Journal of Physical Anthropology* 150: 579–590.

Matsuda I, Izawa K (2008). Predation of wild spider monkeys at La Macarena, Colombia. *Primates* 49:65-68.

Pulliam HR (1973). On the advantages of flocking. *Journal of Theoretical Biology* 38:419–422.

Pulliam HR, Caraco T (1984). Living in groups: is there an optimal group size? In *Behavioural* E*cology, an Evolutionary Approach* (Krebs JR, Davies NB eds.), pp. 122-147 Massachusetts, Sinauer.

Ramos-Fernandez G (2005). Vocal communication in a fission–fusion society: do spider monkeys stay in touch with close associates? *International Journal of Primatology* 26: 1077-1092.

Ramos-Fernández G, Ayala-Orozco B (2003). Population size and habitat use of spider monkeys at Punta Laguna, Mexico. In: *Primates in Fragments* (Marsh LK ed.), pp. 191-209. US, Springer.

Ramos-Fernández G, Aureli F, Schaffner CM, Vick LG. (2018). Ecología, comportamiento y conservación de los monos araña (*Ateles geoffroyi*): 20 años de estudio. In: *La primatología en Latinoamérica 2 / A primatologia na America Latina 2* (Urbani B, Kowalewski M, Teixeira da Cunha RG, de la Torre S, Cortés-Ortiz L eds.). pp. 531-543. Instituto Venezolano de Investigaciones Científicas.

Riveros JC, Schaffner CM, Aureli F (2017) You are not welcome: social exchanges between female spider monkeys (*Ateles geoffroyi*). *International Journal of Primatology* 38: 856–871.

Sherman PT (1991). Harpy eagle predation on a red howler monkey. *Folia Primatologica* 56: 53-56.

Slater K, Schaffner CM, Aureli F (2009). Sex differences in the social behavior of wild spider monkeys (*Ateles geoffroyi yucatanensis*). *American Journal of Primatology* 71: 21-29.

Symington MM (1987). Ecological and social correlates of party size in the black spider monkeys, *Ateles paniscus chamek*. Ph D thesis, Princeton, Princeton University.

Symington MM (1990). Fission-fusion social organization in *Ateles* and *Pan*. *International Journal of Primatology* 11:47-61.

Valero A, Schaffner CM, Vick LG, Aureli F, Ramos-Fernandez G (2006). Intragroup lethal aggression in wild spider monkeys. *American Journal of Primatology* 68: 732-737.

van Schaik CP (1983). Why are diurnal primates living in groups? *Behaviour* 87: 120-144

Zuberbühler K, Jenny D, Bshary R (1999). The predator deterrence function of primate alarm calls. *Ethology* 105: 477-490.

Figure 1: Preyed spider monkeys: a) the adult female attacked by an unidentified