Articles

FIRST RECORD OF PERUVIAN SPIDER MONKEYS (*ATELES CHAMEK*) FEEDING ON A KNOWN MUSHROOM SPECIES, *OUDEMANSIELLA CANARII* (PHYSALACRIACEAE)

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Abstract

A large group of Peruvian spider monkeys, *Ateles chamek*, was recorded feeding on *Oudemansiella canarii* mushrooms in Madre de Dios, Peru. The observed spider monkeys were seen foraging for mushrooms on the forest floor where they grew on downed logs. Spider monkeys are ripe fruit specialists that rarely venture to the forest floor, suggesting that these mushrooms could represent an important though seldom consumed food source. Previous accounts of spider monkeys consuming mushrooms are sparse and do not include identification of the fungi. *O. canarii* mushrooms have a relatively high protein content, possible immunological benefits, and are present during times of relative fruit scarcity in the region. These reasons could explain why the spider monkeys risked a visit to the forest floor to forage for *O. canarii* mushrooms.

Key words: mycophagy, primate, diet, Amazon, terra firme

Resumen

Un grupo de monos araña peruanos, *Ateles chamek*, fue grabado consumiendo hongos de la especie *Oudemansiella canarii* en Madre de Dios, Perú. Estos monos fueron observados forrajeando en el suelo del bosque, donde los hongos crecían en troncos caídos. Los monos araña se especializan en comer frutas maduras y raramente bajan de los árboles para caminar en el suelo. Ésto sugiere que dichos hongos pueden representar un importante, aunque poco consumido alimento. Los registros que existen de monos araña comiendo hongos son pocos y no incluyen la identificación de las especies de estos hongos. Los hongos de *O. canarii* tienen una cantidad de proteína relativamente alta, posiblemente tienen beneficios inmunológicos, y están presentes en el bosque durante tiempos de escasez de frutas. Esas razones podrían explicar por qué los monos araña se atreven a visitar el suelo del bosque para consumir *O. canarii*.

Palabras claves: micofagia, primate, dieta, Amazonía, terra firme

Introduction

Many species of primates are known to occasionally feed on mushrooms, with fungi generally estimated to comprise 1-10% of the diet. The analysis of both stomach contents and direct observations has led to similar conclusions about the relative importance of these fungal food sources (e.g. Gautier-Hion et al., 1980; Guillotin et al., 1994; Castellanos and Chanin, 1996; Simmen and Sabatier, 1996; Hanson et al., 2003; Suarez, 2006). However, mushrooms serve as a more important food source for some monkeys, such as *Callimico goeldii* which spends up to 63% of its feeding time consuming mushrooms (Porter, 2001). Spider monkeys, genus *Ateles*, are highly frugivorous ripe fruit specialists that have diets generally consisting of 70-90% fruit, with the rest of the diet coming mostly from leaves, invertebrates, bark, soil, flowers, aerial roots, palm hearts, and fungi (Di Fiore et al., 2008).

Fruit pulp is typically rich in sugars but contains low amounts of protein, meaning spider monkeys need to feed on other food sources to meet their protein requirements. One study by Felton and colleagues (2009) found that the Peruvian spider monkey, *Ateles chamek*, had a stable daily protein intake despite having a variable total energy intake, suggesting that these monkeys prioritize protein-rich food sources while foraging. Young leaves, insect-infested fruits, and figs (which house protein-rich mutualist wasps) have been suggested as principal sources of protein for these monkeys, but mushrooms offer another, often overlooked but potentially significant source of protein (Simmen and Sabatier, 1996; Felton

et al., 2009; dos Santos-Barnett et al., 2022). However, observations of non-human primates consuming mushrooms are rare, and the mushrooms in question are almost never identified to species, though sometimes the genus or the local common name is given (e.g. Castellanos and Chanin, 1996; Hanson et al., 2003). Individuals of *A. chamek* have previously been observed consuming mushrooms (Wallace, 2005), but as with many other observations of monkey mycophagy, the mushrooms being eaten were not identified. A significant amount of work has been done to characterize spider monkey foraging habits and dietary needs, but this work overwhelmingly focuses on the consumption of ripe fruit. Though ripe fruit represents the majority of the spider monkey diet, identification of the mushrooms that spider monkeys consume can provide further insight into the habits and needs of these endangered primates. I present herein the first record of *Ateles chamek* consuming a known species of mushroom, *Oudemansiella canarii* (Jungh) Höhn, with photo and video footage (Figure 1 and Supplemental Material).

Results

I observed a group of approximately 20 individuals of *Ateles chamek* on the forest floor foraging for mushrooms on decomposing logs. This observation took place at geographical coordinates -12.565068, -70.091767 in a primary terra firme rainforest at Los Amigos Biological Station in Madre de Dios, Peru (Figure 2a) on October 24, 2021 at 9:50 a.m. local time. I recorded photo and video footage of the spider monkeys eating the mushrooms (Figure 1 and Supplemental Material). After picking a mushroom from a downed log, the monkeys retreated from the ground to a higher position in a tree before consuming the mushroom. The monkeys would typically not eat the entire mushroom, and I observed them dropping the uneaten remains to the ground in a manner similar to that seen during frugivory. The monkeys seemed to prefer to consume the mushroom cap while leaving the mushroom stipe untouched. I watched the spider monkeys forage near the mushrooms for 15 minutes before they left the area.

Figure 1. An adult female *Ateles chamek* individual feeding on an *Oudemansiella canarii* mushroom. The spider monkey picked the mushroom from a log on the forest floor before climbing into the understory to eat it. See Supplemental Material for the full video of the spider monkey consuming the mushroom.

Figure 2. a) The area of terra firme forest (-12.565068, -70.091767) where the *Oudemansiella canarii* mushrooms were growing and the spider monkeys were observed foraging; b) *O. canarii* mushrooms growing on a log on the forest floor; c) the undersides of *O. canarii mushrooms.*

I identified the mushrooms (Figure 2b–c) as *Oudemansiella canarii* (Physalacriaceae) through the use of a field guide (Roca, 2016), and the identification was confirmed by the field guide author through photos (M. Roca, pers. comm.). *O. canarii* is a saprotrophic species native to tropical America and Southern Asia, where it is consumed by humans in parts of its range (Petersen and Hughes, 2010). It has also been investigated for its potential to be cultivated on a large scale for food production (see Ruegger et al., 2001; Xu et al., 2016; Acharya et al., 2019).

Discussion

Ateles chamek individuals prefer to stay high in the rainforest canopy, rarely venturing to the forest floor in search of high-quality resources (Di Fiore et al., 2008). A study of another spider monkey species in Suriname, *Ateles paniscus*, observed these monkeys in the forest understory (between 3-15 m above the ground) only during 0.8% of sightings, and the spider monkeys were never seen below 12 m (van Roosmalen, 1985). This preference is likely explained by the necessary shoulder joint and forelimb adaptations required to swing through the forest canopy in a form of suspensory locomotion known as brachiation. These same adaptations for brachiation have resulted in spider monkeys being slow and vulnerable while on the forest floor (Campbell et al., 2005). Most of the observations of spider monkeys on the ground are at mineral licks, where many different animals gather to consume soil rich in hard-to-find minerals, such as sodium (Emmons and Starck, 1979; Campbell et al., 2005; Griffiths et al., 2023). Spider monkeys that regularly visit these mineral licks are observed to be especially cautious and vigilant while in the area, often scanning for predators and resting in the forest canopy near the mineral licks for long periods of time before venturing down to the forest floor (Di Fiore et al., 2008; Link et al., 2011). Observations of *Ateles* species in Ecuador and Peru found that these spider monkeys only went down to the forest floor to feed at mineral licks or on rotten wood, although a Central American species, *A. geoffroyi*, was also observed drinking directly from water sources on the ground during the dry season (Campbell et al., 2005). This suggests that foraging on the forest floor for mushrooms presents a significant but worthwhile risk, similar to feeding at a mineral lick.

Spider monkeys may eat *Oudemansiella canarii* mushrooms for both nutritional and immunological reasons. *O. canarii* cultivated in a lab contained roughly 20% protein by mass, which is much higher than most fruits consumed by spider monkeys (Ruegger et al., 2001). Typical fruits eaten by spider monkeys contain less than 5% protein by mass, though some of the most protein-rich fruits they are known to consume have a protein content similar to that of *O. canarii* (Castellanos and Chanin, 1996; dos Santos-Barnett et al., 2022). In addition, many of the mushrooms in the genus *Oudemansiella*, including *O. canarii*, contain bioactive oudemansins which have been shown to inhibit fungal growth of pathogenic dermatophytes at very low concentrations, suggesting a potential medicinal utility for these mushrooms (Anke, 1997; Rosa et al., 2005). *O. canarii* is also a good source of

bioactive phenolic compounds, which indicates that the mushrooms have antioxidant properties (Acharya et al., 2019).

The availability and distribution of fruit is the most important factor influencing the ranging behavior and habitat use of spider monkeys, with monkeys having a clear preference for areas with more fruit resources (Wallace, 2005). In times of low fruit abundance, spider monkeys are known to travel farther through their home ranges and also supplement their diet more often with alternative food sources, such as invertebrates, leaves, and flowers (Chapman, 1987; Symington, 1987; Wallace, 2005). I observed the *Ateles chamek* individuals feeding on *Oudemansiella canarii* mushrooms in the late dry season during the transition to the rainy season, which is when ripe fruit is less readily available in the region (Symington, 1987). It is therefore possible that these mushrooms presented a more attractive food resource during that time of relative fruit scarcity.

Spider monkeys have highly variable group sizes due to their fission-fusion social structure, which is thought to be partly a result of patterns in ripe fruit availability (Klein and Klein, 1977; Aureli and Schaffner, 2008). Though spider monkeys typically forage in small groups to limit intraguild competition for resource patches, they will gather in larger numbers to rest, to feed on a limited resource such as at a mineral lick, or when there is a large amount of ripe fruit in a small area (Klein and Klein, 1977; Symington, 1987; Shimooka, 2005). In addition, the larger group size observed at mineral licks may reduce the risk of predation to the monkeys consuming soil on the forest floor (Symington, 1987; Link et al., 2011). The group of approximately 20 individuals I observed near the *Oudemansiella canarii* mushrooms was much larger than the usual foraging group size of around 5 individuals that I had observed while following spider monkey groups on numerous other occasions at Los Amigos Biological Station. This suggests that the *O. canarii* mushrooms represented a relatively important resource, as a large number of individuals were grouped together to consume them. However, the spider monkeys did not consume the entirety of the mushrooms present, which could have been due to my presence in the area being perceived as a threat, or due to the poor quality of the remaining mushrooms (see Figure 2b–c).

Overall, spider monkeys that venture to the forest floor in order to forage for *Oudemansiella canarii* mushrooms are putting themselves into a vulnerable position, though it is evidently worth the risk. *O. canarii* mushrooms may represent an attractive food source because they have a relatively high protein content, they can be present during times of relative food scarcity due to patterns in ripe fruit phenology, and they could provide immunological benefits due to their antioxidant properties and oudemansin content (Chapman, 1987; Symington, 1987; Anke, 1997; Ruegger et al., 2001; Rosa et al., 2005; Wallace, 2005). Though the significance of mycophagy in the diet of spider monkeys is still poorly understood, this rarely observed behavior could represent a small yet important part of their diet and foraging habits.

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Supplemental Material. A video of an adult female *Ateles chamek* individual feeding on an *Oudemansiella canarii* mushroom.

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