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# Predation of leaf-cutter ants *Atta opaciceps* Borgmeier, 1939 by the white-tufted marmoset *Callithrix jacchus* (Linnaeus, 1758): study case and review

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**Predação de formiga cortadeira *Atta opaciceps* Borgmeier, 1939 por sagui de tufos brancos *Callithrix jacchus* (Linnaeus, 1758): estudo de caso e revisão**

**Resumo**: Embora conspícuos, alguns eventos de alimentação de pequenos primatas podem ser raros e sazonais. Neste breve relato, descrevemos um grupo de saguis de tufos brancos (*Callithrix jacchus*) predando formigas cortadeiras. O evento ocorreu em uma área peri-urbana na Mata Atlântica no Nordeste do Brasil. O grupo (um par adulto e dois juvenis) foi observado predando formigas aladas (*Atta opaciceps*) à medida em que emergiam do formigueiro para seus voos nupciais. Os saguis desciam ao chão para capturar as formigas, retornando aos seus poleiros em uma árvore próxima (a uma altura aproximadamente de 2 metros) para se alimentarem de suas presas. Todo o evento durou aproximadamente 80 minutos. Enquanto altamente oportunista e presumivelmente limitado a períodos específicos do ano, esse tipo de comportamento pode ser tão frequente quanto os voos nupciais realizados pelas formigas, eventualmente fornecendo uma fonte adicional de alimento, destacando a plasticidade da ecologia alimentar dos saguis. Além disso, de acordo com os dados disponíveis, as interações ecológicas (predação, e associação de forrageamento) entre calitriquídeos e formigas parecem desempenhar um papel importante, principalmente em ambientes degradados, enfatizando a habilidade dos calitriquídeos de explorar uma ampla gama de recursos. Adicionalmente, o presente relato também evidencia a raridade desses eventos, necessariamente associados ao voo nupcial das formigas, assim como a importância de registrar esses comportamentos oportunistas para que haja uma compreensão mais completa das adaptações ecológicas de *C. jacchus* e dos demais calitriquídeos às mudanças de habitat.

**Palavras chave**: Callitrichidae, sagui comum, ecologia alimentar, Hymenoptera.

**Abstract**: Although conspicuous, some feeding events of small primates may be rare and seasonal. In this brief report, we describe a group of common marmosets (*Callithrix jacchus*) preying on leaf-cutter ants. The event took place in a peri-urban area in the Atlantic forest of northeastern Brazil. The group

(an adult pair and two juveniles) was observed preying on winged ants (*Atta opaciceps*) as they emerged from their terrestrial nest for their nuptial flight. The marmosets descended to the ground to capture the ants and then returned to their perches in a nearby tree (at a height of approximately 2 meters) to feed on their prey. The whole sequence of events lasted approximately 80 min. While highly opportunistic, and presumably limited to specific periods of the year, such behavior may happen as often as the nuptial flights performed by the ants, occasionally providing an additional source of food, highlighting the plasticity of the feeding ecology of the marmosets. Moreover, according to the available data, the ecological interactions (predation, and foraging association) among callitrichids and ants seem to play an important role mainly in degraded environments, emphasizing the ability of callitrichids to exploit a wide range of resources. Furthermore, this record also evidences the rarity of such events as well as, necessarily associated to the ants' nuptial flight, the importance of registering these opportunistic behaviors for the more complete understanding of the ecological adaptations of *C. jacchus* and other callitrichids to habitat changes.

**Key words**: Callitrichidae, common marmosets, feeding ecology, Hymenoptera.

The diet composition of a species is mainly influenced, among other factors, by its body size (Sailer *et al*. 1985). Such factors will determine the metabolic requirements of each species and, in turn, the profitability of capturing a given type of food item, given the costs and benefits of foraging process (Garber 1987). In the case of insectivorous platyrrhines, the larger-bodied capuchins, *Cebus* (Erxleben 1777) and *Sapajus* (Kerr 1792), typically exploit relatively small, but abundant prey, such as ants and termites (Izawa 1979; Freese & Oppenheimer 1981; Freitas *et al*. 2008), while the smaller callitrichids, such as *Callithrix* (Erxleben 1777) and *Saguinus* (Hoffmannsegg 1807), prefer larger, less gregarious prey, such as grasshoppers, beetles, and moths (Ferrari & Ferrari 1989; Martins & Setz 2000; Porter 2001; Hilário & Ferrari 2010). These differences are related to contrasting foraging strategies. While the larger capuchins typically forage destructively, the small callitrichids are stealthy ambush foragers (Freese & Oppenheimer 1981; Stevenson & Rylands 1988). Like other callitrichids, the common marmoset or the white-tufted-ear-marmoset *Callithrix jacchus* (Linnaeus 1758) is a small monkey (adult body weight 300–450 g: Stevenson & Rylands 1988) with a diverse diet consisting primarily of fruit, plant gums, arthropods and small vertebrates (Alonso & Langguth 1989; Castro *et al*. 2000; Amora *et al*. 2014; Beltrão-Mendes *et al*. 2018).

Specific events, however, may modify these more typical patterns of predatory behavior. For example, the reproductive swarms of hymenopterans may provide an opportunistic food source for a variety of insectivorous species. The reproductive swarms of dispersing leaf-cutter ants *Atta* (Fabricius 1805) include as many as 2.000 queens and up to 10.000 males (Marinho *et al*. 2011). As they emerge from nest, these individuals typically pause to open and stretch their wings before departing, a moment of extreme vulnerability to predation by birds, bats, armadillos and even other ants (Moser 1967; Mintzer & Vinson 1985). In this brief report, we describe the prey feeding behavior for *C. jacchus* on a reproductive swarm of *Atta opaciceps* Borgmeier, 1939 at a site in northeastern Brazil. It is evident both the rarity of such events (which may occur once a year at most sites) and the importance of registering these opportunistic behaviors for a more complete understanding of the ecological and behavioral adaptations of *C. jacchus* to environmental changes, and by extension, for other callitrichids.

The event we report here occurred on March 12, 2015, and took place at the Federal University of Sergipe campus – UFS (10º55' S, 37º06' W; datum WGS84), municipality of São Cristóvão, Northeastern Brazil. The study site is a parkland-type urban environment, characterized by university buildings with ample lawns and abundant trees, surrounded on three sides by remnants of Atlantic forest and bodies of water (see Rocha *et al*. 2010). Along the UFS campus, *Atta opaciceps* is relatively common, as well as the marmosets (Authors - personal observations). Marmosets are well habituated to humans because of the high frequency of encounters within the Campus, some of them are also frequently provisioned (Authors - personal observations). Thereby, they can be observed from a close distance (ca. 2-4 m) without disturbance and any perceived sign of behavioral change. The observed group of marmosets was

composed by a pair of breeding adults and two juveniles, with an estimated home range of approximately 3.5 ha (see Silvestre *et al.* 2016), characterized by a matrix of relatively scattered trees (mainly *Anacardium occidentale*, *Clitoria fairchildiana*, *Pithecellobium dulce*, *Schinus terebinthifolius*, and *Terminalia catappa*) between a few buildings.

On March 12, 2015, at approximately 16:00 h, while walking between buildings, one of the authors (PAR) opportunistically observed the marmosets near an ant nest in the ground, and recorded the event with a portable handy camera (Canon PowerShot SX50 HS). At the moment, the winged individuals of the ants' colony were in the nest beginning to swarm. The marmosets positioned themselves in a tree adjacent to the nest (approximately 2 m height), when each individual started to leap down to the ground, one at a time, to capture winged females, quickly returning to the tree to feed on the insect (**Figure 1**). This behavior was observed continuously during a period of approximately 80 min, that is, until 17:20 h, when the marmoset group moved away. Returning the laboratory, we measured the duration of the event and the food intake of each individual.

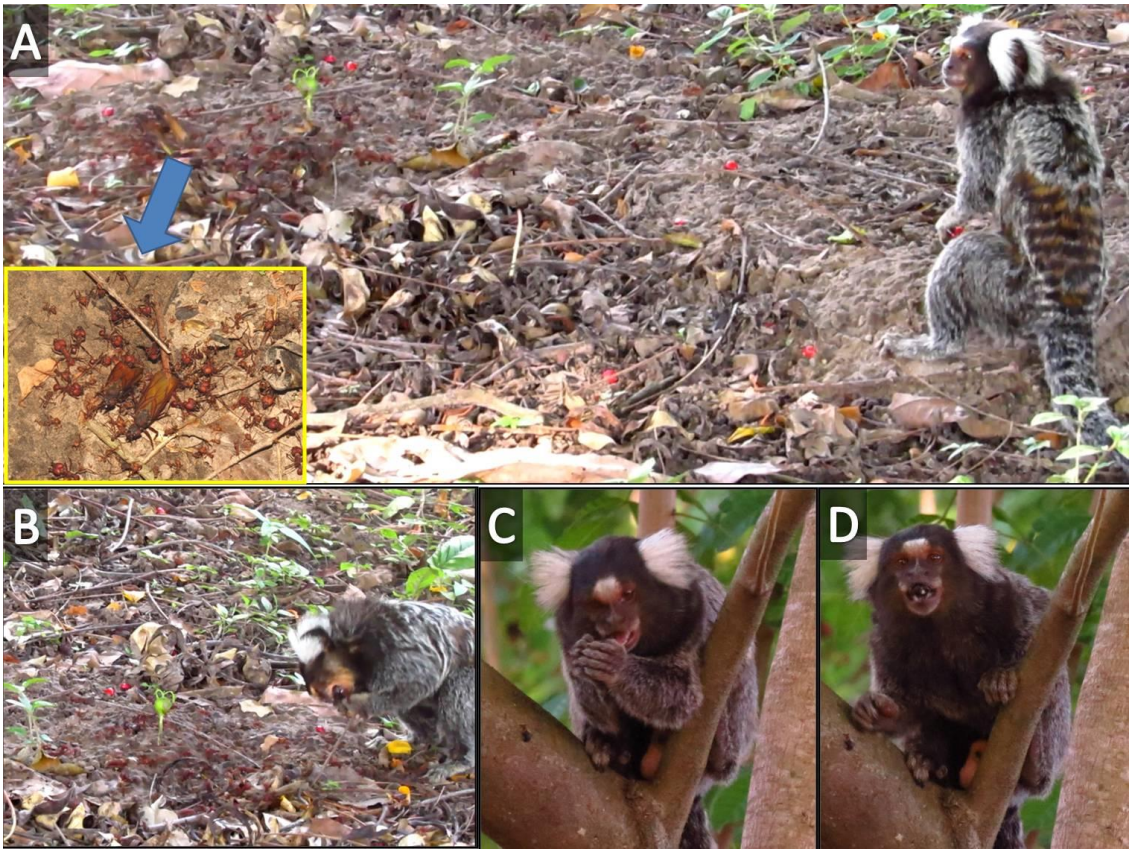


**Figure 1**. *Callithrix jacchus* preying upon winged individuals (alates) of *Atta opaciceps* during the nuptial swarming of that ant species, at the Campus of the Federal University of Sergipe, São Cristóvão, northeastern Brazil. In the details it is possible to see (**A**) the marmoset in the ground close to the ant nest, with the blue arrow pointing from the nest to the details of the alates ants; (**B**) the marmoset biting an ant while still holding it with both hands; (**C**) the marmoset biting an ant in a tree close to the nest, holding it with both hands; and (**D**) the marmoset masticating the ant before swallowing it.

By analyzing the video, we estimated that 20 ants were preyed on by marmosets during the event (one ant preyed every 16 min by each marmoset). The predation upon hymenopterans appears to be a relatively common phenomenon to callitrichids (**Table 1**), as well as "anting", in which the marmosets associate with army ants during their foraging, accompanying their columns systematically to prey on the arthropods and small vertebrates disturbed by the passing column (Rylands *et al.* 1989; Lyra-Neves *et al.* 2007; Melo Júnior & Zara 2007). During anting events, however, the marmosets do not feed on the ants themselves, but primarily on arthropods,

such as crickets, grasshoppers, cockroaches, spiders, moths, cicadas, bugs, and beetles (Rylands *et al.* 1989; Martins 2000; Melo Júnior & Zara 2007).

**Table 1**. Number of records for *Callitrichidae* primates and its association to ant species according to their Ecological Interactions – EI (FA = Foraging Association; P = Predation), Habitat Conditions – HC (NF = Native Forest; PU = Peri-Urban; SF = Secondary Forest), and Biomes – B (AM = Amazonia; AF = Atlantic Forest; CA = Caatinga; CE = Cerrado).

| Primate species | Ant species | EI | | HC | | | B (Number of records) | References |
|---|---|---|---|---|---|---|---|---|
| | | FA (anting) | P | NF | PU | SF | | |
| ***Callimico*** | | | | | | | | |
| *Callimico goeldii* | Not detailed | | 1 | 1 | | | AM(1) | Pook & Pook (1981) |
| ***Callithrix*** | | | | | | | | |
| *Callithrix aurita* | *Labidus praedator* | 1 | | | | 1 | AF(1) | Martins (2000) |
| *Callithrix flaviceps* | *Eciton burchelli* | 1 | | | | 1 | AF(1) | Rylands *et al.* (1989) |
| *Callithrix geoffroyi* | *Eciton burchelli* | 2 | | | | 2 | AF(2) | Rylands *et al.* (1989); Passamani & Rylands (2000) |
| *Callithrix jacchus* | *Atta opaciceps* | | 1 | | 1 | | AF(1) | **Present study** |
| | *Atta* sp. | | 1 | | 1 | | AF(1) | Mendes Pontes & Soares (2005) |
| | Not detailed | | 5 | 1* | 4 | | AF(4), CA(1)* | Maier *et al.* (1982)**; Souto *et al.* (2007); Schiel *et al.* (2010); Abreu *et al.* (2016)*; Silvestre *et al.* (2016) |
| *Callithrix kuhlii* | *Eciton burchelli* | 1 | | 1 | | | AF(1) | Rylands *et al.* (1989) |
| | *Labidus praedator* | 1 | | 1 | | | AF(1) | Rylands *et al.* (1989) |
| *Callithrix penicillata* | *Labidus praedator* | 2 | | 1 | 1 | | AF(1), CE(1) | Melo Júnior & Zara (2007) |
| | *Labidus* sp. | | 1 | | 1 | | CE(1) | Silva *et al.* (2008) |
| ***Mico*** | | | | | | | | |
| *Mico intermedius* | *Eciton burchelli* | 1 | | 1 | | | AM(1) | Rylands *et al.* (1989) |
| | *Labidus praedator* | 1 | | 1 | | | AM(1) | Rylands *et al.* (1989) |
| ***Saguinus*** | | | | | | | | |
| *Saguinus fuscicollis* | Not detailed | | 1 | 1 | | | AM(1) | Izawa (1975) |
| *Saguinus nigricollis* | Not detailed | | 1 | 1 | | | AM(1) | Izawa (1978) |
| **Total** | | **10** | **11** | **9** | **8** | **4** | **21** | |

* – Related items are marked with an asterisk (*); ** – Spontaneous consumption by a captive group.

The opportunistic predation of insects in large agglomerations has also been reported to other primates, even for species in which invertebrates constitute a small portion of the diet. This is the case of *Callicebus coimbrai* Kobayashi & Langguth 1999, which has been observed preying upon caterpillars (*Pseudosphinx tetrio* Linnaeus 1771) during a seasonal great abundance of those insects in the site (Souza-Alves *et al.* 2011). As insects represent a valuable nutritional source (Nickle & Heymann 1996; Rothman *et al.* 2014), whose lipid content may reach up to 40% of its body weight (see Camargo *et al.* 2013; Rumpold & Schlüter 2013), they can be an important supplement to the typical diet of some species (Rothman *et al.* 2014). Martins (2000) suggests that those opportunistic events are very important in the feeding ecology of insectivorous primates, due to unpredictability of distribution of small insects. Further, Souza & Calouro (2018) observed the predation upon ants by *Plecturocebus toppini* Thomas, 1914 on a small urban forest fragment. The combination of variables such as highly energy-demanding periods, or seasonal fluctuations of food availability suggest that even small insects such as ants may represent an important and alternative food source on degraded habitats, including urban environments (**Table 1**). Although it does not mean that habitat condition is determinant to such interactions.

In Attine ants, nuptial swarms generally occur only after the colony has developed for three years, they are typically synchronized among different colonies, and occur just prior to a period of rainfall (Marinho *et al.* 2011). While common marmosets at the study site are known to prey on hymenopterans of the families Mutilidae, Vespidae, and Formicidae (Silvestre *et al.*

2016), the only other record of predation for *Atta* ants by callitrichids has been made by Mendes Pontes & Soares (2005), in which the behavior was only briefly mentioned, despite ants (non-detailed species) have been listed as a common prey for *C. jacchus* according to few preview ecological studies (Maier *et al.* 1982; Schiel *et al.* 2010; Abreu *et al.* 2016). This is perhaps surprising given the vast body of ecological and behavioral data available on these primates (e.g., Goldizen 1987; Stevenson & Rylands 1988; Ford et al. 2009; Rylands & Mittermeier 2013), and the relative scarcity of reported interactions among callitrichid and ant, namely: predation or association on foraging, 21 to the date (**Table 1**). Some ant species, nonetheless, have been listed as preys of callitrichid primates (**Table 1**), mainly army ants from genus *Eciton* and *Labidus*, whilst a number of records remained without identification of ant species.

The available data indicates that the majority of reported interactions (16) have been observed in *Callithrix* species along the Atlantic Forest (13), Cerrado (2), and Caatinga (1), one of those spontaneously performed by a captive group (**Table 1**). This may be an artifact of the number of field studies carried out with *Callithrix* species compared to other callitrichids, notoriously the Amazonians (in this case, genus *Callimico*, *Mico*, and *Saguinus*). It is worth mention, however, that Rylands *et al.* (1989) point out that *Leontopithecus* species, the only other Atlantic Forest callitrichid genus, does not prey upon or associate with ants due to their foraging strategies.

The event reported does not represent a more flexible diet of common marmosets than previously known, once its potential to eat ants has already been observed (see Mendes Pontes & Soares 2005; Silvestre *et al.* 2016), but it emphasizes the ability of the species to explore opportunistic food resources, as observed by Amora *et al.* (2013). This ability may be a key for *C. jacchus* to cope with food scarcity in disturbed habitats, like peri-urban/urban sites, and in highly seasonal environments, like the Caatinga biome, which comprises most of the geographic distribution of the species.

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