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BIODIVERSITY AND CONSERVATION - SHORT COMMUNICATION

An intense predation event of the most abundant Amazon tree by capuchin monkeys

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ABSTRACT

Palms are among the most abundant trees in the Amazon and a key element in the structure and function of the forest. However, impacts of plant–herbivore interactions on this functionally important group, particularly under environmental disturbance, remain poorly understood. Here, we report, for the first time, an intense predation event of the palm *Euterpe precatoria* Mart., by capuchin monkeys (*Sapajus apella*). The event was likely driven by an ENSO drought-driven food scarcity and resulted in 70% mortality of palm individuals from a population in Central Amazonia. While arborescent palms may often appear resilient to short-term drought due to access to shallow water tables or internal water storage, shifts in plant–herbivore interactions during these disturbances could weaken this resilience and potentially impact palm populations in tropical forests.

KEY WORDS: Palm; *Euterpe precatoria*; *Sapajus*; capuchin monkey diet; herbivory; mortality; drought

Um episódio intenso de predação da árvore mais abundante da Amazônia por macacos-prego

RESUMO

As palmeiras são as árvores mais abundantes da Amazônia e um componente-chave da estrutura e do funcionamento da floresta. No entanto, os impactos das interações planta–herbívoro sobre este grupo funcionalmente importante, particularmente sob condições de perturbação ambiental, ainda são pouco compreendidos. Neste estudo, nós relatamos pela primeira vez um intenso evento de predação da palmeira *Euterpe precatoria* Mart. por macacos-prego (*Sapujus apella*). Esse evento foi provavelmente desencadeado por escassez alimentar associada a uma seca induzida pelo El Niño–Oscilação Sul (ENSO) e resultou em uma mortalidade de aproximadamente 70% dos indivíduos de uma população na Amazônia Central. Embora palmeiras arborescentes possam frequentemente parecer resilientes a secas de curto prazo devido ao acesso a lençol freático superficial ou ao armazenamento interno de água, mudanças nas interações planta–herbívoro durante estes distúrbios podem enfraquecer essa resiliência e potencialmente afetar as populações de palmeiras em florestas tropicais.

PALAVRAS-CHAVE: Palmeiras; *Euterpe precatoria*; *Sapajus*; dieta de macaco-prego; herbivoria; mortalidade; seca

The role of herbivores in increasing tree mortality during drought events is one of the key uncertainties in understanding how climate change will impact forests (Hamann et al. 2021). While plant-herbivore dynamics and their interaction with drought and climate change have received considerable attention in temperate systems (e.g., interactions with bark beetles) their effects on tropical forests remain poorly understood (Sampaio and Scariot 2010, Hamann et al. 2021). Nevertheless, such interactions can have substantial ecological consequences. In Panama, for example, an El Niño-Southern Oscillation (ENSO) associated drought shifted the diet of collared peccaries (*Dicotyles tajacu* L.) to consumption of the bromeliad *Aechmea magdalenae* causing a 45% decrease in the plant population (Ticktin 2003). Here, we report a similar event driven by the opportunistic foraging behaviour of capuchin monkeys (*Sapajus apella* L.), which resulted in the mortality of approximately 70% of individuals within a single study population of *Euterpe precatoria* Mart., the most abundant tree species in the Amazon basin (ter Steege et al. 2013). This event was likely triggered by an intense ENSO-

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associated drought depleting alternative food resources of the capuchin monkeys (Wright et al. 1999, Gómez-Posada 2012, Dunham et al. 2018). As arborescent palms account for seven of the twenty most abundant tree species in the Amazon, understanding the drivers and consequences of drought-driven predation is critical for predicting future forest composition and resilience under increasingly frequent and severe droughts (Hamann et al. 2021). Although palms are not true trees in a strict botanical sense, they are commonly included in Amazonian forest tree inventories (e.g. ter Steege et al. 2013) as functional analogues due to their comparable structural role in forest canopies and understories; we therefore follow this convention for consistency with the literature.

Predation of palms by capuchin monkeys consist in the removal of the fleshy apical meristem (palm heart/*palmito*), leaving the palm top broken with the leaves still attached by the outer part of the stem (Figure 1). Palm trees are particularly vulnerable to this form of attack as they have only one apical meristem and little regenerative ability, leading to plant mortality (Brocardo et al. 2010, Portela and Dirzo 2020). Nevertheless, the spatial and temporal variation of palm apical meristem predation and its drivers remain poorly documented (Rasec-Silva et al. 2023). Existing reports of palm predation by capuchin monkeys are largely restricted to the Brazilian Atlantic Forest (Brocardo et al. 2010, Siberdt 2025), where such herbivory has substantially reduced local populations of dominant palm species (Portela and Dirzo 2020, Santos et al. 2023). However, documented negative demographic effects on palm populations have primarily been reported in disturbed habitats (reduction in forest area and increase in capuchin monkey population), and the population-level consequences of this behaviour have not been evaluated in all areas where it has been observed. To our knowledge, no reports of *E. precatoria* predation by capuchin monkeys in the Amazon rainforest exist.

Capuchin monkeys are one of the most common and widespread Neotropical primates due to their high behavioural plasticity (Gómez-Posada 2012). They feed mainly on fruits and arthropods of a wide range of species, and their handling capacity allows the use of alternative resources such as palm apical meristem (Spironello 1991, Gómez-Posada 2012). Palms are of particular importance to tropical frugivores during the dry season, as many Amazonian palm species fruit during this period, conferring a competitive advantage over ephemeral



Figure 1. *Euterpe precatoria* Mart. individuals with the peeled leaf-bases above the stem and the apical meristem (palm-heart/*palmito*) removed by capuchin monkeys. Arrows indicate where the apical meristem was present prior to removal by capuchin monkeys. Observations made between the 21st and the 23rd of August 2016 in the Cuieiras Reserve near Manaus (2°59'S, 60°21'W).

dicotyledonous trees (Peres 1994a). A few studies indicate that under resource scarcity, capuchin monkeys may shift their diet from fruits to alternative food sources (Peres 1994b, Brocardo et al. 2010, Gómez-Posada 2012, Siberdt 2025).

In the dry season of 2016, during an extreme ENSO drought (Marengo et al. 2024), and while carrying out unrelated field work in the region, we noticed a substantial predation event of *E. precatoria* by capuchin monkeys in the Cuieiras Reserve near Manaus, ZF2 km 34, in Central Amazonia (2°59'S, 60°21'W). The area encompasses a large tract of continuous *terra-firme* forest embedded within a broader relatively intact forest matrix, with minimal fragmentation compared to other tropical regions. Although not a strictly protected conservation unit, the site is part of a long-term research landscape (INPA/LBA) with limited anthropogenic disturbance, primarily associated with scientific infrastructure such as access roads and instrumented towers. From the 21st to the 23rd of August 2016, we observed a notable number of *E. precatoria* palms which were broken at the top, while their leaves remained green and turgid (Figure 1). Concurrently, we observed capuchin monkeys (*S. apella*) in the vicinity, and witnessed capuchin individuals feeding on palm hearts. To attribute predation specifically to capuchins, we inspected closely a few predated palms and found feeding and tooth marks in the palm heart region. The feeding marks were characteristic of capuchin monkeys and unlikely to have been caused by other animals, although we cannot fully exclude the interference of other fauna. We decided to systematically register this predation event and carried out a survey of predated palms on the 25th and 26th of August. We quantified all palms along a 1.2 km transect with a sampling width of 10 m, crossing a *terra-firme* valley forest where the palm population was present. We established a fixed survey width of 5 m on each side of the trail to standardize sampling effort, using a measuring tape. To classify palm heights, we used a calibrated measuring stick as a reference, categorizing individuals into three height classes: less than 1 m, between 1 and 2.5 m, and greater than 2.5 m.

We counted 267 palm individuals in total (>1 m in height), out of which 140 individuals had a height of 1-2.5 m and 127 of >2.5m. From the total of 267 sampled palms, 70% (187) were predated. All predated palms still had green, turgid leaves with no signs of old, dry foliage, suggesting the predation happened shortly before our survey. Some of the affected individuals reached up to 8 m in height and were reproductive. Taller individuals (> 2.5 m) were generally less predated than shorter individuals (50% vs 88%; Chi-squared test: $\chi^2 = 42.7$; $p < 0.001$; Figure 2). However, individuals <1 m in height remained abundant and none were predated.

To evaluate the potential impact of this predation event on the affected *E. precatoria* population, we used a matrix population model available for a *terra-firme* forest in Bolivia (Peña-Claros and Zuidema 2000). We simulated the impacts of predation of medium (1-2.5m of height; J2 stage) and tall individuals (>2.5m of height; J3 to A3 stages) on the asymptotic population growth rate. According to our simulation, λ can decrease by 0.9% when 88% of the medium individuals are predated, but up to 8.8% when just 50% of individuals from the tallest size class are predated, and 9.3% when medium and tall individuals are simultaneously predated. This is particularly concerning as previous studies conducted in tropical palms also found that recruitment and survival during the tall but pre-reproductive stages are the most critical ones in changing λ (Pinard and Putz 1992, Pinard 1993).While the results need to be interpreted with care regarding the broader applicability and impacts across the Amazon, given it focuses on one single population, it offers valuable first insights into the potentially severe impacts of predation events on *E. precatoria* populations.

In a comprehensive study, Portela and Dirzo (2020) report *Euterpe edulis* Mart. palm heart predation by capuchin monkeys in fragmented and defaunated landscapes in the Atlantic Forest, where disturbances altered resource availability, increasing predation pressures. They found that predation markedly reduced population growth of *E. edulis*, with λ declining to ~0.68 for over a decade, well below stability thresholds, and leading to predictions of local extinction of this palm within ten years. Climatic disturbances, like severe ENSO drought, may also alter resource availability and temporarily increase the pressure on palm populations in the Amazon, however more data are needed to link drought events with dietary shifts and predation of palms. Whether the observed reduction in population growth rate may similarly lead to local population collapse of *E. precatoria*, particularly in the context of projected increases in Amazon drought disturbances, remains speculative and an important question for future research.

Low resource availability due to the strong 2015-2016 ENSO drought may explain the observed mass predation event. ENSO extremes can generate pronounced legacy

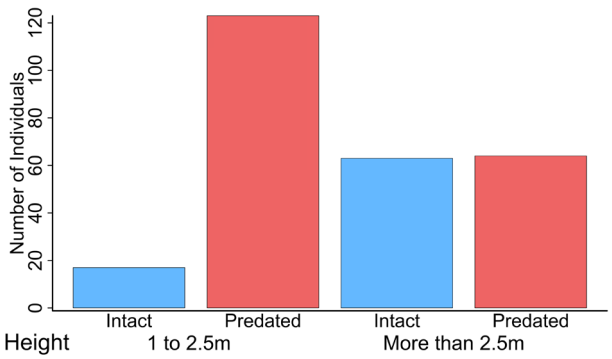


Figure 2. Number of *Euterpe precatoria* Mart. individuals of two different size-classes (medium and tall) in the Central Amazon being either predated by capuchin monkeys or left intact.

effects on tropical forest phenology and function (Dunham et al. 2018, Pastana et al. 2021), which can cause widespread famine (Wright et al. 1999). We did not notice many fruits at the Cuieiras site when meristem predation occurred, in agreement with Peres (1994b) assessment of low resource availability in the Central Amazon in August. As meristems are more energetically costly to manipulate and take more feeding time than fruits, shifts in the diet of capuchin monkeys towards palm heart might become more frequent only when other resources are limited (Siberdt 2025). The preferential predation of medium individuals (1 to 2.5 m) suggests that this size class is less energetically costly to capuchin monkeys than taller sizes, and differences in meristem hardness may be related to it. The absence of predation of small individuals may reflect their limited amount of meristem biomass which might be energetically too costly or may expose monkeys to risks by being at ground level. We also observed occasional predation on *Bactris* spp. despite abundant stem spines, but these events were rare and not quantified.

The report of an intense predation event of *E. precatoria* palms by capuchin monkeys in Central Amazon during an extreme drought (Pastana et al. 2021) may also have implications for forest-based economies, including açaí management (Barros et al. 2024). In fact, a similar predation of planted açaí and pupunha (*Euterpe oleracea* and *Bactris gasipaes*) by capuchin monkeys on plantations in Amapá and Pará has recently been reported to us by a local farmer (Valdeci Baia da Silva, personal communication, December, 2025). Although palms may be comparatively well adapted to acute drought events, for example through access to shallow water tables (Sousa et al. 2020) or through large internal water storage capacity that potentially buffers short-term water deficits (Martius et al. 2024, Martius et al. 2026), drought-mediated interactions with herbivores could substantially undermine this apparent drought resilience. Although data on the temporal and spatial frequency of palm predation by capuchin monkeys are lacking, our results suggest that such events may constitute an important, yet underappreciated, driver of palm population dynamics under ongoing climate change in the Amazon.

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