

Tool use by Amazonian capuchin monkeys during predation on caiman nests in a high-productivity forest

Kelly Torralvo^{1,2} · Rafael M. Rabelo^{2,3} · Alfredo Andrade^{1,2} · Robinson Botero-Arias^{2,4}

Received: 7 December 2016 / Accepted: 28 February 2017
© Japan Monkey Centre and Springer Japan 2017

Abstract Descriptions of new tool-use events are important for understanding how ecological context may drive the evolution of tool use among primate traditions. Here, we report a possible case of the first record of tool use by wild Amazonian capuchin monkeys (*Sapajus macrocephalus*). The record was made by a camera trap, while we were monitoring caiman nest predation at Mamirauá Reserve in Central Amazonia. An adult individual was registered in a bipedal posture, apparently using a branch as a shovel to dig eggs out of a nest. Caiman eggs are frequently depredated by opportunistic animals, such as the capuchin monkeys. As the Mamirauá Reserve is covered by a high-productivity forest, and caiman eggs are a high-quality food resource seasonally available on the ground, we believe that tool use by capuchins is more likely to be opportunity driven, rather than necessity driven, in our study site.

Keywords Behavior · Nest predation · Opportunistic tool use · Primate culture · *Sapajus*

Introduction

Tool use is defined as “the external employment of an unattached or manipulable attached environmental object to alter more efficiently the form, position, or condition of another object, another organism, or the user itself, when the user holds and directly manipulates the tool during or prior to use and is responsible for the proper and effective orientation of the tool” (Shumaker et al. 2011). Feeding is the main context of tool use by primates (Bentley-Condit and Smith 2010), and recent studies have focused on the role of ecological conditions in shaping foraging tool use (Koops et al. 2014). The necessity hypothesis posits that tools are used mainly when food resources are scarce (de Moura and Lee 2004). The opportunity hypothesis posits that encounter rates with tool materials and tool-required food resources drive tool-use behavior (Spagnoletti et al. 2012; Koops et al. 2014).

Among the Neotropical primates, capuchin monkeys have long been known for being the only species able to use tools in captivity and in the wild (Fragaszy et al. 2004; Shumaker et al. 2011). The use of a tool to crack encased food items on a hard substrate has been observed only in some wild populations of the capuchin belonging to the genus *Sapajus*. Most of the observations concern capuchins inhabiting dry savanna-like environments (Ottoni and Izar 2008), rarely a dry forest (Souto et al. 2011), and never the Amazon rainforest.

Capuchin monkeys are widely distributed across the Amazon (Alfaro et al. 2012) and are known for their generalist and opportunistic feeding behavior (Fragaszy et al. 2004; Visalberghi and Fragaszy 2013). The large-headed capuchin (*Sapajus macrocephalus*) has been identified as one of the top predators of caiman eggs in long-term caiman-nest monitoring in a floodplain forest in

✉ Kelly Torralvo
kellytorralvo@hotmail.com

¹ Programa de Pós-Graduação Em Ecologia, National Institute of Amazonian Research, Manaus, AM, Brazil

² Mamirauá Institute for Sustainable Development, Tefé, AM, Brazil

³ Centro de Estudos Integrados Da Biodiversidade Amazônica, National Institute for Amazonian Research, Manaus, AM, Brazil

⁴ Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL, USA

Central Amazonia (K. Torralvo, in preparation). During the low-water season, caiman females build their mound nests with leaves, sticks and soil (Villamarín et al. 2011). Caiman eggs are frequently depredated by opportunist animals, such as jaguars (*Panthera onca*), tegu lizards (*Tupinambis teguixim*), humans (*Homo sapiens*) and capuchins, which are among the main predators of these eggs (Da Silveira et al. 2010; Barão-Nóbrega et al. 2014).

Descriptions of novel tool-use events, even when based on few records, help in our understanding of the factors favoring the emergence of tool use among primates. Here, we report a egg-predation event which we believe may be the first record of tool use by wild Amazonian capuchin monkeys (*S. macrocephalus*) in a high-productivity flooded forest. The record was made by a camera trap, while we were monitoring black caiman, *Melanoshucus niger*, nest predation at Mamirauá Reserve—a large protected area of high-productivity forests in Central Amazonia.

Methods

The Mamirauá Sustainable Development Reserve is a protected area located between Japurá, Solimões and Auati-Paraná Rivers, in the Central Amazon, Brazil. The reserve contains a *várzea*, a type of floodplain forest, which is entirely and seasonally flooded by nutrient-rich white-water rivers, which increase substantially the primary productivity of these forests in comparison with the upland *terra firme* forests (Prance 1979; IDSM 2010).

The study was conducted during the low-water seasons (October-December) of 2013 and 2014, while we were monitoring caiman-nest predation in 63 nests. Nests were monitored with camera traps (Reconyx PC800), programmed to take pictures at 10-s intervals, for as long as the camera sensor identified movement. The overall sampling effort was of 6923 camera-trap days. The tool-use episode reported here was opportunistically recorded at one of the nests (2°48'29"S, 65°4'49"W), which was monitored for 20 days (approximately 470 h).

Results

We recorded a total of 117 predation events in 25 caiman nests. Capuchins were responsible for 39% ($n = 46$) of the predation events. Nests were raided by single individuals or groups of two to four, which usually approached the nest, took the eggs and carried them away to another place on the ground or a nearby tree (Fig. 1f).

We registered a single episode that we interpreted as tool use by *S. macrocephalus* during a predation event on a caiman nest. This episode was registered approximately

366 h after the monitoring of the nest had started. On this occasion, two capuchin monkeys started the nest-predation event at 1434 hours and finished it at 1518 hours, after 34 min. The tool use occurred at 1501 hours, 18 min after the monkeys started removing eggs (Fig. 1). At 1501:28 hours, one of the individuals, apparently an adult male, was registered over the nest looking for the eggs (Fig. 1a). At 1501:38 hours, this individual was photographed in a bipedal posture, holding a long stick of wood (about 25 cm) with his two hands, apparently using it as a shovel to dig into the nest and remove the upper layers of the nest to access the eggs in the nest mound (Fig. 1b). Ten seconds later, a second individual appeared in the scene, behind the first one, which was manipulating the nest interior (Fig. 1c). At 1501:58 hours, the first individual left the scene carrying an egg (Fig. 1d), while the second one kept manipulating something in the nest (Fig. 1e).

Discussion

We believe that the episode reported here may represent a case of tool-use behavior and, if this is correct, is the first record of tool use by a capuchin species in the Amazon forest. Although we recognize the possibility that the monkey was only removing a stick from the nest because it was an obstacle to its hand search for the eggs, we believe that it is more likely to be a tool-use episode based on (1) the posture of the individual, which was holding the stick with his two hands in opposite positions (left hand supinated and right hand pronated), in the same way we would hold a shovel; and (2) the litter being moved between the stick and the hind limbs of the monkey (see yellow circle in Fig. 1b). Our interpretation is that the stick was used as a shovel to dig into the nest and remove the leaf litter, and we consider that the episode described here fits the definition of tool use sensu Shumaker et al. (2011).

We also believe that the use of tools can be advantageous in caiman egg predation. In a predation event, opening the nest is the first step to reaching the internal chamber. This is probably hindered by compressed rotting vegetation and by the common presence of thorns of *Bactris* sp. (Torralvo, personal observation), which could encourage the use of a stick instead of the hands by a capuchin. But if this type of tool-use behavior is advantageous in this population, why did we not record more events of this in the other monitored nests? In fact, if this behavior is common, it is possible that we did not register other tool-use events because our study was actually designed to record the predator species of caiman eggs. We stress that only direct observations or videos could provide appropriate evidence of tool-use behavior in this population.

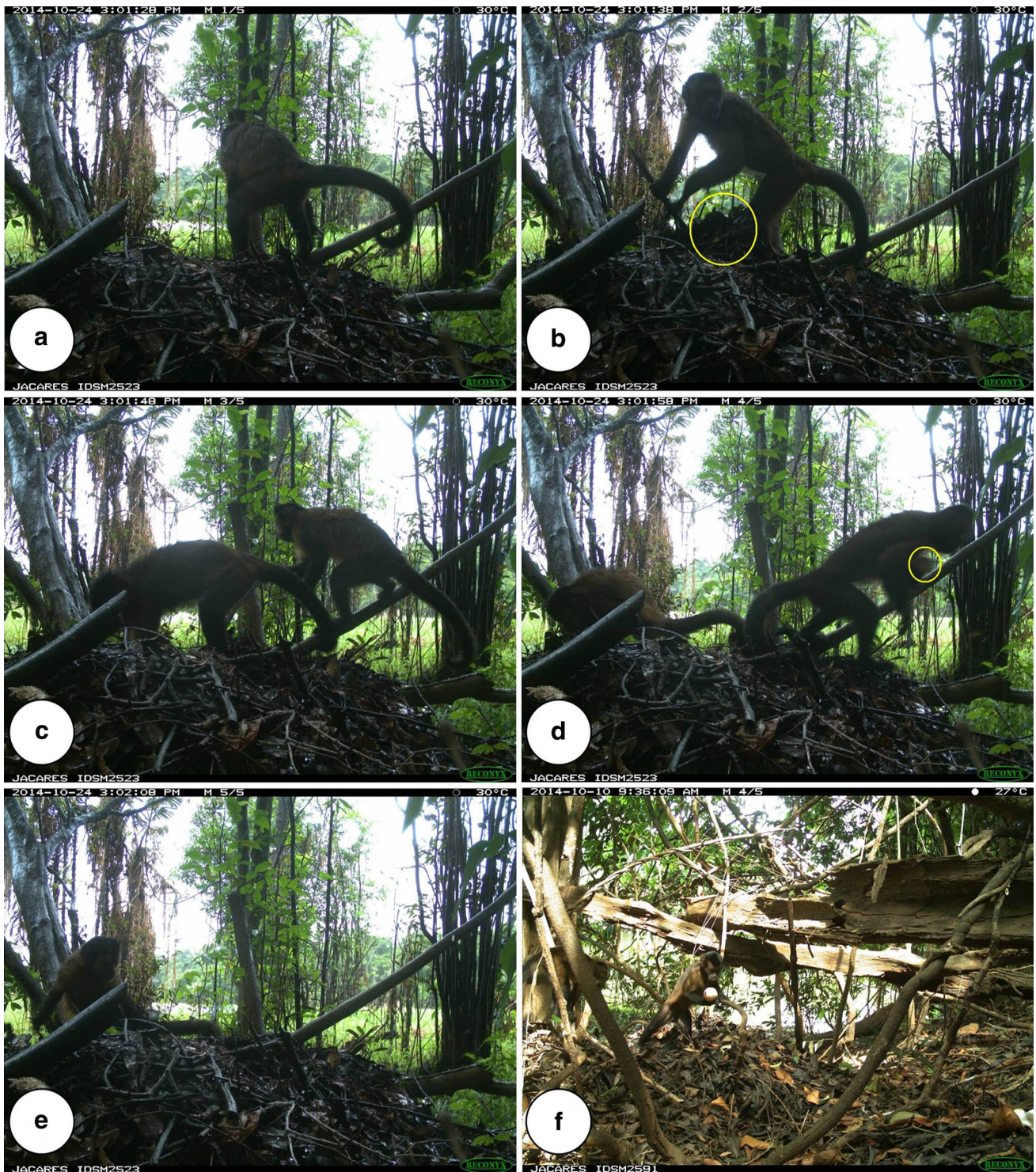


Fig. 1a–f Record of tool use by *Sapajus macrocephalus* at Mamirauá Reserve, Central Amazon. **a** Individual above a black caiman nest. **b** Individual using a stick as a shovel to remove leaf litter—note the litter being dislodged near the hind limbs of the monkey (*yellow*

circle). **c** A second individual reaches the monitored scene, while the first one is reaching into the nest interior. **d** Individual leaving the nest holding one egg (*yellow circle*), while the second one keeps reaching into the nest (**e**). **f** Capuchin in a bipedal posture carrying an egg away

Most reports of tool use by wild capuchins have been reported for species inhabiting arid environments, such as *caatinga* and *cerrado* in Brazil (Ottoni and Izar 2008),

which led a few researchers to propose the food-scarcity hypothesis for feeding-associated tool use (de Moura and Lee 2004). However, systematic observations of tool use

have been carried out on two wild groups of bearded capuchins in Fazenda Boa Vista (Piauí State, Brazil) to test whether tool use was related to food scarcity or to the opportunities to perform it. Spagnoletti et al. (2012) found that the rate of stone tool use by capuchins was correlated with palm nut availability and not with monthly availability of fruits and invertebrates; moreover, the rate of tool use did not differ between the group that received little additional food (provisioned) and the one that did not.

The Amazonian *várzea* forests are more productive than *terra firme* forests due to their seasonal flooding by nutrient-rich white-water rivers, which fertilize the soil (Prance 1979). This is why primates tend to have higher abundances in *várzea* forests (Peres 1997). Therefore, it seems unlikely that food scarcity would account for tool use in the Mamirauá population.

It has been shown that capuchin monkeys use tools opportunistically when they encounter food items that require this behavior (Spagnoletti et al. 2012; Koops et al. 2014). In the Mamirauá forests, when the water level decreases after 4–6 months of flood (Ramalho et al. 2009), the environment offers new resources for exploitation on the ground. This is when caiman females build their nests, piling leaves and branches and placing their eggs under a mound of vegetation (Rueda-Almonacid et al. 2007; Villamarín et al. 2008). Even though nests are commonly guarded by the females (Lang 1987), caiman eggs are frequently taken by animals with opportunistic habits, such as the capuchins (Da Silveira et al. 2010; Barão-Nóbrega et al. 2014). Since the tool-use episode recorded here occurred in a forest with high primary productivity, and the caiman eggs are a high-energy food resource seasonally available on the ground, we provide evidence that opportunity, rather than necessity, may be the main factor promoting tool-use invention and transmission among primate cultures.

Although we interpreted this event to be a case of tool use, we acknowledge that this interpretation is debatable. It is worth noting that the possible single tool-use event presented here was registered opportunistically. The interval at which the camera traps took pictures (10 s) was not designed to carefully record the manipulative ability of capuchin monkeys. Therefore, we believe that a long-term study designed specifically to study the capuchin's behavior, with direct observations or videos instead of pictures, would be more appropriate for the description of capuchin predation behavior, their ability to manipulate nest materials, and perhaps reveal other tool-use events.

Acknowledgements This research was funded by the Instituto de Desenvolvimento Sustentável Mamirauá (IDSM-OS/MCTI) and by the IDSM AQUAVERT project funded by the Programa Petrobras Ambiental. The caiman-nest monitoring is a project of the Caiman Conservation and Management Research Program of IDSM. We

thank the Infrastructure and Logistics Team at Mamirauá Institute for supporting our fieldwork. Vanessa Schmitt, Erenilson de Oliveira, Hidelbrando Silva, Ozimar Silva, Erivan Castro, João Carvalho and Helson Pinto Martins assisted with the fieldwork. We also thank Patrícia Izar for her valuable suggestions regarding an early draft of the manuscript, Bill Magnusson for the final English review, the editor and one anonymous reviewer for their contributions that improved the manuscript.

References

- Alfaro JW, Boubli JP, Olson LE et al (2012) Explosive Pleistocene range expansion leads to widespread Amazonian sympatry between robust and gracile capuchin monkeys. *J Biogeogr* 39:272–288
- Barão-Nóbrega JAL, Marioni B, Villamarín F et al (2014) Researcher disturbance has minimal impact on natural predation of caiman nests in central Amazonia. *J Herpetol* 48:338–342
- Bentley-Condit V, Smith EO (2010) Animal tool use: current definitions and an updated comprehensive catalog. *Behav* 147:185–221
- Da Silveira R, Ramalho EE, Thorbjarnarson JB, Magnusson WE (2010) Depredation by jaguars on caimans and importance of reptiles in the diet of jaguar. *J Herpetol* 44:418–424
- de Moura ACA, Lee PC (2004) Capuchin stone tool use in caatinga dry forest. *Science* 306:1909
- Fragaszy DM, Visalberghi E, Fedigan L (2004) The complete capuchin: the biology of the genus *Cebus*. Cambridge University Press, Cambridge
- IDSM (2010) Plano de gestão reserva de desenvolvimento sustentável mamirauá RDSM. MCTI/IDSM-OS, Tefé
- Koops K, Visalberghi E, Van Schaik CP (2014) The ecology of primate material culture. *Biol Lett* 10:1–4
- Lang JW (1987) Crocodylian behavior: implications for management. In: Webb GJW, Manolis SC, Whitehead PJ (eds) *Wildlife management: crocodiles and alligator*. Surrey Beatty, Chipping Norton, pp 273–294
- Otoni EB, Izar P (2008) Capuchin monkey tool use: overview and implications. *Evolut Anthropol* 17:171–178
- Peres CA (1997) Primate community structure at twenty western Amazonian flooded and unflooded forests. *J Trop Ecol* 13:381–405
- Prance GT (1979) Notes on the vegetation of Amazonia. III. The terminology of Amazonian forest types subject to inundation. *Brittonia* 31:26–38
- Ramalho EE, Macedo J, Vieira T et al (2009) Ciclo hidrológico nos ambientes de várzea da Reserva de Desenvolvimento Sustentável Mamirauá—médio rio Solimões, período de 1990 a 2008. *Uakari* 5:61–87
- Rueda-Almonacid JV, Carr JL, Mittermeier RA et al (2007) *Las tortugas y los cocodrilianos de los países andinos del trópico*. Panamericana, Bogotá
- Shumaker RW, Walkup KR, Beck BB (2011) *Animal tool behaviour: the use and manufacture of tools by animals*. John Hopkins University Press, Baltimore
- Souto A, Bione CBC, Bastos M et al (2011) Critically endangered blonde capuchins fish for termites and use new techniques to accomplish the task. *Biol Lett* 7:532–535
- Spagnoletti N, Visalberghi E, Verderane MP et al (2012) Stone tool use in wild bearded capuchin monkeys, *Cebus libidinosus*. Is it a strategy to overcome food scarcity? *Anim Behav* 83:1285–1294
- Villamarín F, Botero-Arias R, Thorbjarnarson J, et al (2008) Hatching success of black caiman (*Melanosuchus niger*) nests and spatial relations on egg collection by humans in the Mamirauá

- Sustainable Development Reserve, Brazil. In: Crocodiles. Proceedings of the 19th Working Meeting of the Crocodile Specialist Group of the Species Survival Commission of IUCN—the World Conservation Union convened at Santa Cruz de la Sierra. IUCN/SSC Crocodile Specialist Group, Santa Cruz de la Sierra, pp 333–340
- Villamarín F, Marioni B, Thorbjarnarson JB et al (2011) Conservation and management implications of nest-site selection of the sympatric crocodilians *Melanosuchus niger* and *Caiman crocodilus* in Central Amazonia, Brazil. *Biol Conserv* 144:913–919
- Visalberghi E, Fragaszy DM (2013) The Etho-Cebus Project: stone-tool use by wild capuchin monkeys. In: Sanz CM, Call J, Boesch C (eds) *Tool use in animals: cognition and ecology*. Cambridge University Press, New York, pp 203–222