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- 1977; Boesch and Boesch, 1983, 1984, 1989; Goodall, 1986; McGrew *et al.*, 1997; De Waal, 2016) and bonobos (Jordan, 1982; Ingmanson, 1996; McGrew and Marchant, 1997) but in the last two decades there has been an increase of studies and experiments of tool use by monkeys including macaques (Huffman *et al.*, 2010; Leca *et al.*, 2012; Leca *et al.*, 2016), baboons (van Lawick-Goodall *et al.*, 1973) and capuchins (Fernandes, 1975; Antinucci and Visalberghi, 1986; Westergaard and Fragazsy, 1987; Boinski, 1988; Ritchie and Fragazsy, 1988; Anderson, 1990; Chevalier-Skolnikoff, 1990; Visalberghi, 1990; Anderson and Henneman, 1994; Phillips, 1998; Jalles-Filho and Grassetto, 2008).
- Panger *et al.* (2002) describe some tool-use behaviors that include the “leaf wrap” processing technique, where monkeys wrapped objects such as *Automeris* spp. caterpillars and *Sloanea terniflora* fruits in leaves before rubbing them against a substrate. Fragazsy *et al.* (2004) stated “it is probable that monkeys wrap these objects to reduce the contact with chemical and mechanical defenses that both *Automeris* caterpillars and *Sloanea terniflora* fruit have” (Fragazsy *et al.*, 2004). However there also have been reports of capuchins (*Cebus capucinus*) rubbing *Sloanea terniflora* fruits and *Automeris* caterpillars directly without first wrapping them in leaves (Shumaker *et al.*, 1980; Panger *et al.*, 2002). Similarly Katz and Katz (1936) observed six captive monkeys (3 *Chlorocebus sabaues* and 3 *Cebus capucinus*) wrapping sticky bananas in leaves before picking them up. Huffman *et al.* (2010) observed Japanese macaques (*Macaca fuscata*) wrapping leaves around stones, metallic and plastic objects as a pattern of stone handling behavior (Nahallage and Huffman, 2007; Huffman *et al.*, 2010).
- Persea americana* Mill. (avocado) is a tree native to Central America (Vinha *et al.*, 2013), cultivated in tropical and subtropical climates around the world, belonging to the family Lauraceae. This species has long been divided into three botanically distinguishable groups designated as horticultural races, namely Mexican, Guatemalan and West Indian. The Mexican race is the only one with anise scented leaves (Bergh *et al.*, 1973). The leaves of anise avocado (as it is commonly known in the region) range in size from 8 cm to over 15 cm long with widths varying according to the form of the leaf. This race is distributed from 1,600 to 2,000 meters above sea level (m.a.s.l.) and is characteristic of subtropical wet forest (Mendizabal, 1998). These leaves also have a strong anise smell and flavor due to their estragole content, which is less toxic than anethol, the major volatile component of the characteristic scent of anise (*Pimpinella anisum*) that contains higher levels of toxicity (Marcus and Lichtenstein, 1979; King and Knight, 1992; Sagerro-Nieves and Bartley, 1995; Ozcan and Chalchat, 2006).

USE OF LEAF-WRAPPING AS A FEEDING TECHNIQUE BY CAPTIVE WHITE-FACED CAPUCHIN MONKEYS (*CEBUS CAPUCINUS*) AT THE “ROSY WALTHER” METROPOLITAN ZOO, HONDURAS

Judith M. Luna Lainez

Introduction

Benjamin B. Beck gives us the best-known definition of tool-use as “the external deployment of an unattached environmental object to alter more efficiently the form, position or condition of another object” (Shumaker *et al.*, 2011). Many observations on tool use have been described in chimpanzees (McGrew and Tutin, 1973; McGrew,

Methods

During a study of fur rubbing behavior (Luna, in prep.) in captive white-faced capuchin monkeys (*Cebus capucinus*

limitaneus) (Hershkovitz, 1949; Boubli *et al.*, 2012; Ruíz-García *et al.*, 2012) at the “Rosy Walther” Metropolitan Zoo, Tegucigalpa, Honduras, a group of eight capuchin monkeys where observed for a total of 120 daylight hours, over 8 months. The group of capuchin monkeys was formed of an adult pair, four juveniles and two infants. For this study, plant materials of different species (“Hoja Blanca” (*Buddleja americana*), “Indio Desnudo” (*Bursera simaruba*), “Aguacate Indio” (*Persea americana*: Guatemalan race), “Guaruma” (*Cecropia peltata*), and “Cordoncillo” (*Piper aduncum*)) were provided for the capuchin monkeys. Leaves of anise avocado (*Persea americana*: Mexican race) were also provided. We collected *ad libitum* data on all leaf wrapping events that occurred during our study.

Observations

On four different occasions, two males (an adult and a juvenile) and two females (an adult and a juvenile), were seen wrapping four items of their daily diet (corn cob, watermelon, banana and pineapple) with a leaf of anise avocado (*Persea americana*). On all four occasions, they picked up the leaves, which seemed to be selected specifically from visual inspection indicating possible prior knowledge of the species. However, there are no data as to whether the monkeys were raised in captivity or captured from the wild.

On the first occasion (February 8 2016), the alpha female took a piece of corn cob in one hand from the feeding bucket; in the other hand she had a leaf of anise avocado. She wrapped the piece of corn cob with the leaf and rubbed the wrapped food against the ground. After rubbing she opened it and ate the corn, throwing away the leaf. Minutes later she took a piece of watermelon, wrapped it with a new leaf of the same species and beat it against the ground, again eating the fruit and throwing away the leaf when finished. On the same occasion, the alpha male was observed wrapping a piece of banana with a leaf of anise avocado and beating it against the ground. When finished, the subject ate the banana mass and licked the leaf simultaneously. Both incidents lasted between 8 and 10 minutes, with the subjects then returning to consume other foods.

On the second occasion (February 24 2016), the alpha male wrapped a piece of corn cob in an anise avocado leaf and pounded it against the ground, unwrapped it and took just the leaf, which he squeezed and licked. Minutes later, the same individual repeated the action with a banana, wrapping it, eating the fruit and licking the leaf.

On the third occasion (February 25, 2016), the alpha male was observed picking up the leaves of anise avocado and wrapping a banana. He beat it and rolled it against the ground until the banana was mashed. He then bit the mashed banana, simultaneously licking the leaf. When he was done, an infant male licked the leaf that the alpha male had left behind.

On the fourth occasion (April 13, 2016) a sub-adult male wrapped a piece of pineapple in a leaf of anise avocado, bit it, unwrapped it and then continued to eat the pineapple without the leaf.

Discussion

None of the fruits provided in Metropolitan Zoo (watermelon, bananas, corn cob, orange, pineapple, melon) contain harmful substances, nor involve difficulties in processing or handling. Only on occasions when anise avocado leaves were provided did the capuchins wrap the food and lick not only the fruit pulp but the leaf as well. When leaves were not provided the animals easily took and ate the fruits mentioned. When leaves were provided those leaves were not taken immediately, but several minutes or hours after being available. The phytochemical composition of leaves of *Persea americana* includes saponines, alkaloids, phenols and mineral elements with high antioxidant properties such as magnesium, phosphorus and potassium, and other classes of minerals such as sodium, calcium, zinc, iron and copper (Arukwe *et al.*, 2012). They contain high levels of flavonoids, bioactive compounds that have been related to a decrease of different deteriorative processes owing to their ability to reduce the formation of free radicals. Also they have been related to a lower risk of heart disease and contain strong anti-carcinogenic and anti-inflammatory properties and are used to treat digestive problems (Leela and Vipin, 2008; Arukwe *et al.*, 2012; Vinha *et al.*, 2013).

Possible explanations for this behavior in the focal group include: a) Due to the fact that capuchin monkeys have a strong tendency to smash, bang and pound almost anything they handle, wrapping the fruit before they smash it could be a form of tool use to easily pound and rub fruit against a substrate to soften it and/or extract the juice; or b) the animals recognize and seek a specific compound in the leaf that could help them season the fruits prior to consumption with the flavor of anise avocado. The second explanation seems more likely as anise avocado leaves are very aromatic and have a strong flavor. However, the monkeys have not been observed performing this behavior with the leaves of other aromatic and flavored species such as cinnamon (*Cinnamomum verum*), basil (*Origanum vulgare*), rosemary (*Rosmarinus officinalis*) or mint (*Mentha spicata*) even though these materials have been offered. If this behavior served for softening fruits or extracting juices, it might be expected that leaves of other species would be used when anise avocado is not offered. Alternatively this behavior could be a habit of certain individuals within this captive group. So far there is no definitive explanation for the purpose of this behavior, and as this is the first report of leaf-wrapping around a non-noxious material, future systematic research should be carried out to better understand this behavior.

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A COMPARISON OF PRIMATE SPECIES ABUNDANCE AND DIVERSITY BETWEEN A PROTECTED AND AN INDIGENOUS-OWNED SITE IN THE SUMACO BIOSPHERE RESERVE, ECUADOR

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Introduction

Fully protected areas surrounded by successive buffer zones are a standard strategy to protect areas of high biodiversity, intended to strike a balance between the necessity to conserve wildlife and the needs of local people. Effective buffer zones should reduce detrimental edge effects caused by abrupt changes in land-use and allow at least some animal and plant species to extend their range beyond the core boundary (Sayer, 1991). However, they should also be places where the traditional land rights and practices of local people are respected, and allow the sustainable use of natural resources. Achieving this equilibrium is difficult; and it is important for our understanding of the success of buffer zones (if success is measured in terms of the presence and abundance of target species) to make regular comparisons of their species assemblages with their associated core areas in order to ascertain their effectiveness and identify which species are most resilient to human presence. In this study we investigate how primate species assemblages and their estimated abundance differ at two sites situated in the protected core area and buffer zone of the Sumaco Biosphere reserve, eastern Ecuador. While human impact in the protected area is very low, our buffer zone site is situated within territory owned by an indigenous Kichwa community that maintains a reasonably traditional lifestyle, where primates are subject to disturbance, hunting, and use as pets. Although these sites are linked by continuous forest cover, they are separated by both distance, altitude,