



SHORT NOTE

FLOWER EATING BY THE TOCO TOUCAN (*RAMPHASTOS TOCO*) IN AN ANTHROPOGENIC LANDSCAPE DURING THE DRY SEASON**Paulo Antonio Silva**

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Abstract · Toucans rarely feed on plant parts other than ripe fleshy fruits. Here, I report observations of flower exploitation by Toco Toucans (*Ramphastos toco*), in Sao Paulo state, Brazil. This toucan fed on the buds, floral tissues, whole flowers and nectar of seven plant species. I made the observations in a highly anthropogenic landscape, mostly at the height of the dry season, when the availability of ripe fleshy fruits declines in the area. The exploitation of flowers reported here is consistent with an opportunistic foraging habit in which toucans resort to eating flowers to obtain nutrients, energy, and water when ripe fleshy fruits are scarce.

Resumo · Consumo de flores pelo Tucano Toco (*Ramphastos toco*) em uma paisagem antropogênica durante a estação seca

Os tucanos raramente se alimentam de partes de plantas que não sejam frutos carnosos maduros. Aqui, eu reporto observações de exploração de flor pelo Tucano Toco (*Ramphastos toco*) no estado de São Paulo, Brasil. Essa espécie de tucano se alimentou de botões, tecidos florais, flores inteiras e néctar de sete espécies de plantas. Eu fiz as observações em uma paisagem altamente antropogênica, principalmente no auge da estação seca, quando a disponibilidade de frutos carnosos maduros declina na área. A exploração de flores reportada aqui é consistente com um hábito alimentar oportunista em que os tucanos recorrem ao consumo de flores para obter nutrientes, energia e água quando frutos carnosos maduros são escassos.

Key words: Cultivated plants · Florivory · Ramphastidae · *Ramphastos toco* · Seasonal diet · Urban environments

INTRODUCTION

Toucans (Ramphastidae, 50 species), a group of large-bodied Neotropical birds, feed mostly on ripe fleshy fruits and sometimes eat arthropods, small vertebrates, and eggs (Remsen et al. 1993, Sick 1997). Since the habit of eating flowers by toucans is unusual, only a brief report has been devoted to the subject (Riley & Smith 1986). In fact, before this study the limited evidence of flower consumption by toucans came from flower filaments found in the stomach of the Yellow-throated Toucan (*Ramphastos ambiguus* Swainson, 1823) (Wetmore 1968), and flowers accounting for 2.8% of foraging bouts in a large study on the diet of four toucan species (Galetti et al. 2000). Even for generalist toucans with flexible diets, such as the Toco Toucan (*Ramphastos toco*, Stadius Muller, 1776), there is a lack of records of flower consumption (Ragusa-Netto 2008, França et al. 2009, Ragusa-Netto 2010, 2013, Santos & Ragusa-Netto 2013). Furthermore, although Ragusa-Netto (2006) and Parrini & Raposo (2010) observed Toco Toucan feeding on flowers, little attention was paid to this behavior.

Flower eating by frugivorous birds, such as toucans, is a relevant behavior since flowers are sources of nectar, pollen, petals, and other floral tissues, which provide energy, nutrients, and water (Janzen 1980, Riley & Smith 1986, Terborgh 1986, Nicolson et al. 2007, Mlcek & Rop 2011). As toucans have a large body size and usually fly for long distances in search of fruits (Terborgh et al. 1990, Galetti et al. 2000, Graham 2001), they require a high intake of energy, nutrients, and water to cover the cost of their daily trips (Ragusa-Netto 2006). In addition, the importance of flowers in toucan diet may change with the season; for example, in markedly seasonal regions, flowers could be more relevant as a food and water source during fleshy fruit shortages in the driest period (Janzen 1980, Terborgh 1986).

Here, I report observations of Toco Toucans feeding on flowers during the dry season. I also emphasize the possibility of toucans obtaining nutrients, energy, and water according to floral properties and feeding behavior.

METHODS

Study area. Records of exploiting flowers by the Toco Toucan were obtained in urbanized and rural areas at Ilha Solteira, state of São Paulo, Southeast Brazil (20°25'S, 51°20'W; 380 m.a.s.l.). Ilha Solteira has an area of ~ 70,000 ha, but ~ 97% of it has been

modified by human activities. Currently, there are extensive sugar cane plantations, together with large areas used for small crops and dairy farming. Natural vegetation is mainly composed of linear riparian forest as well as small and isolated fragments of dry and semideciduous forest. In many of these fragments, there has been a deep physiognomic shift due to the spreading of the exotic tree species *Leucaena leucocephala* (Fabaceae). Perhaps in part because of their allelopathic nature (Ahmed et al. 2008), *L. leucocephala* dominated and homogenized many fragments and severely altered their understory and forest canopy. In the urban and suburban areas, there are a number of green spaces, squares, gardens, and streets, all well wooded, but with a mixture of native and exotic tree species. In small farms in the surrounding rural areas, it is also common to grow exotic and native trees in gardens and orchards. The climate of the region is markedly seasonal, with a wet season from October to March and a dry season from April to September (Silva & Melo 2013).

Field procedures. I gathered the records of feeding on flowers while watching blooming trees of a variety of plant species from 2003 to 2018. One to six trees per species were watched throughout the day (06:00 to 18:00 h). Observations were made in sessions of 30 min to 4 h per tree. One foraging bout consisted of the continuous period in which an individual or flock of Toco Toucans remained exploiting the flowers. For each bout, I noted date, hour, number of toucans, foraging time, floral resource ingested, and feeding behavior. When possible, I photographed a toucan to obtain the details of the feeding behavior.

RESULTS AND REMARKS

I observed the Toco Toucan consuming floral resources in seven tree species belonging to three families. I describe such feeding activities on a tree-species basis.

1) *Handroanthus chrysotrichus* (Bignoniaceae). During the mid-afternoon on 17 September 2011, I observed two toucans visiting a tree (~ 10 m tall) of this native species near a road in the urban perimeter. The plant was in full bloom and the toucans removed and swallowed 1–3 yellow flowers for a brief foraging period (~ 2 min). *Handroanthus (Tabebuia)* spp. entomophilous flowers produce nectar with 23–30% sugar concentration (Barros 2001, Souza et al. 2004), thus, the flowers provide an energy source for toucans.

2) *Spathodea campanulata* (Bignoniaceae). On 6 May 2009, between 07:00 and 12:00 h, I observed 2–4 Toco Toucans foraging in the treetop of this African tree species in the landscaped cemetery at Ilha Solteira. On this occasion, the toucans were primarily exploiting *Schefflera actinophylla* (Araliaceae) ripe fruits. However, toucans opportunistically perched on blooming *S. campanulata* trees planted nearby, always in search of nectar (2–7 min foraging bouts; n = 8). The bird-pollinated flowers of *S. campanulata* are large orange cups that secrete a large amount of nectar (~ 1 ml) with 9–25% sugar concentration (Rangaiah et al. 2004). The toucans invariably cut the base of the petals with their beaks to gain access to the nectar, therefore obtaining mainly energy and water via florivory, specifically nectar stealing.

3) *Carica papaya* (Caricaceae). On 7 April 2011, at 09:37 h, I recorded two Toco Toucans visiting a papaya tree (~ 4 m

tall) cultivated in an orchard in a rural area. The plant was in full bloom, and both toucans removed and ingested 7–10 whole flowers in a bout that lasted ~ 3 min. The cream-colored flowers adapted to insect pollination are nectariferous and rich in pollen (Dey et al. 2016), and thus are a highly profitable nutritional and energy resource for toucans.

4) *Bombax ceiba* (Malvaceae). On 22 July 2003, at 17:53 h, I obtained the first observation of a Toco Toucan visiting a tree of this Asian plant species in a suburban garden. The toucan quickly removed and ingested three buds (Figure 1a) before leaving the plant. Over the following years, during flowering from July to August (the peak of the dry season), I have observed Toco Toucans regularly exploiting flowers in different *B. ceiba* trees located in urban and suburban areas (n = 29 foraging bouts). Toucans usually visit the plant in pairs, but I often registered up to 14 toucans simultaneously exploiting *B. ceiba* flowers. These perching bird-pollinated flowers are large and cup-shaped (~ 6 cm in circumference), with fleshy red petals (Figure 1b). They contain large quantities of nectar, ~ 0.4 ml per flower (Khandure & Kumar 2017), with a 19–25% sugar concentration (Raju et al. 2005). Toucans fed on buds, petals, stamens (thus pollen), stigma, and nectar (Figure 1b). This suggests that blooming *B. ceiba* offers a range of opportunities for the toucans to feed and drink water. Toucans are sometimes legitimate flower pollinators, touching the stamens and stigma by inserting their beaks in the open flowers to drink the nectar. However, in most visits, Toco Toucans destroy many buds and open flowers during feeding bouts that last up to 7 min.

5) *Ceiba pentandra* (Malvaceae). This tree species is typical of the Amazon region; thus, it is an exotic regional plant in southeast Brazil. The species is represented by only one tree (~ 25 m tall) planted in an urban garden. In some years it does not produce flowers – sometimes, it bears buds, aborting them long before the anthesis. However, in some years it blooms massively, e.g., as it did in June–July 2006, 2009, 2013, and 2018. The nocturnal, bat-pollinated cream-colored flowers (~ 5 cm length) of *C. pentandra* contain residual nectar still available in the early daylight hours (Gribel et al. 1999). Even with a reduced nectar sugar concentration (less than 10%; Gribel et al. 1999), this floral reward attracts a variety of birds (cf. Toledo 1977) such as the Toco Toucan. From 3–7 July 2018, between 07:00 and 09:00 h, I observed 1–9 toucans eating nectar as well as swallowing open flowers and buds (Figure 1c) in pre-anthesis (n = 6 foraging bouts). Toucans exploit the blooming plant usually in brief visits, for up to 3 min. They can destroy many flowers and in no case make legitimate visits that could lead to pollination.

6) *Ceiba pubiflora* (Malvaceae). In the late morning on 13 May 2017, I observed two Toco Toucans feeding in the treetop of a blooming tree (~ 15 m tall) planted in an urban garden. The pink hummingbird- and insect-pollinated flowers of this native tree, despite their large size, accumulate only low amounts of nectar (1.7 µl average), with ~ 15% sugar concentration (Silva 2018). Thus, they are moderately profitable in terms of energy availability. The visit of the toucans lasted approximately 2 min, and both individuals swallowed a few floral buds and mostly open flowers (Figure 1d).

7) *Ceiba speciosa* (Malvaceae). This native plant species has floral features very similar to those of *C. pubiflora* flowers. On 27 April 2003, at 07:03 h, I observed two Toco Toucans visiting a plant (~ 5 m tall) in the Ilha Solteira cemetery.



Figure 1. a) Toco Toucan (*Ramphastos toco*) collecting a *Bombax ceiba* bud; b) Toco Toucan drinking nectar on a *B. ceiba* flower; c) Toco Toucan eating a *Ceiba pentandra* bud; d) Toco Toucan eating an entire flower of *Ceiba pubiflora*. All observations made in Ilha Solteira, São Paulo, Brazil (photographs by the author).

Both toucans swallowed buds but also caused damaged to open flowers due to petal, stamen, and stigma consumption. Their visit was brief, and the toucans left the plant after 2 min.

DISCUSSION

Riley & Smith (1986) contended that toucans eating flowers is not a simple case of obtaining an alternative food source since flowers are also eaten when ripe fleshy fruits are abundant. These authors suggest that there are actually nutritional reasons compelling toucans to eat flowers because the flowers must be rich in lipids, proteins, and carbohydrates. In fact, my records suggest that, at least regarding nectar sugar concentration (thus, energy availability), visits to flowers by the Toco Toucan seem significant in terms of energy gains. However, although the nectar contains sugar and sometimes amino acids, inorganic lipids, alkaloids, and terpenoids (Nicolson et al. 2007), nectar alone may be insufficient to sustain large frugivorous birds (Ganesh & Devy 2000). Perhaps because of this, florivory was the principal way by

which the Toco Toucan exploited blooming plant species. This foraging activity seems to be highly profitable on a nutritional basis. For example, pollen is a very rich source of proteins, amino acids, carbohydrates, lipids, carotenoids, and flavonoids (see Mlcek & Rop 2011 and included references). Petals and other parts of flowers are a source of the aforementioned compounds as well as of vitamins, organic acids, a number of minerals, and antioxidants (Mlcek & Rop 2011). Thus, by ingesting buds, floral tissues, and whole flowers, toucans can gain a considerable mixture of energy and nutrients (Riley & Smith, 1986, Ganesh & Devy 2000).

Unlike Riley & Smith (1986), my observations suggest that flower eating by Toco Toucans is also related to a decline in ripe fleshy fruit availability. Toucans visited blooming trees exclusively in the dry season. Fruiting data previously collected in the area (Silva & Melo 2013) show a decline in the supply of ripe fleshy fruits in this period (Figure 2). In the midst of this fruit scarcity, mostly cultivated plant species such as *B. ceiba*, *S. campanulata*, *Ceiba* spp., and *C. papaya* provided flowers which were consumed by Toco Toucans. This is consistent with an opportunistic foraging habit (*sensu* Franklin

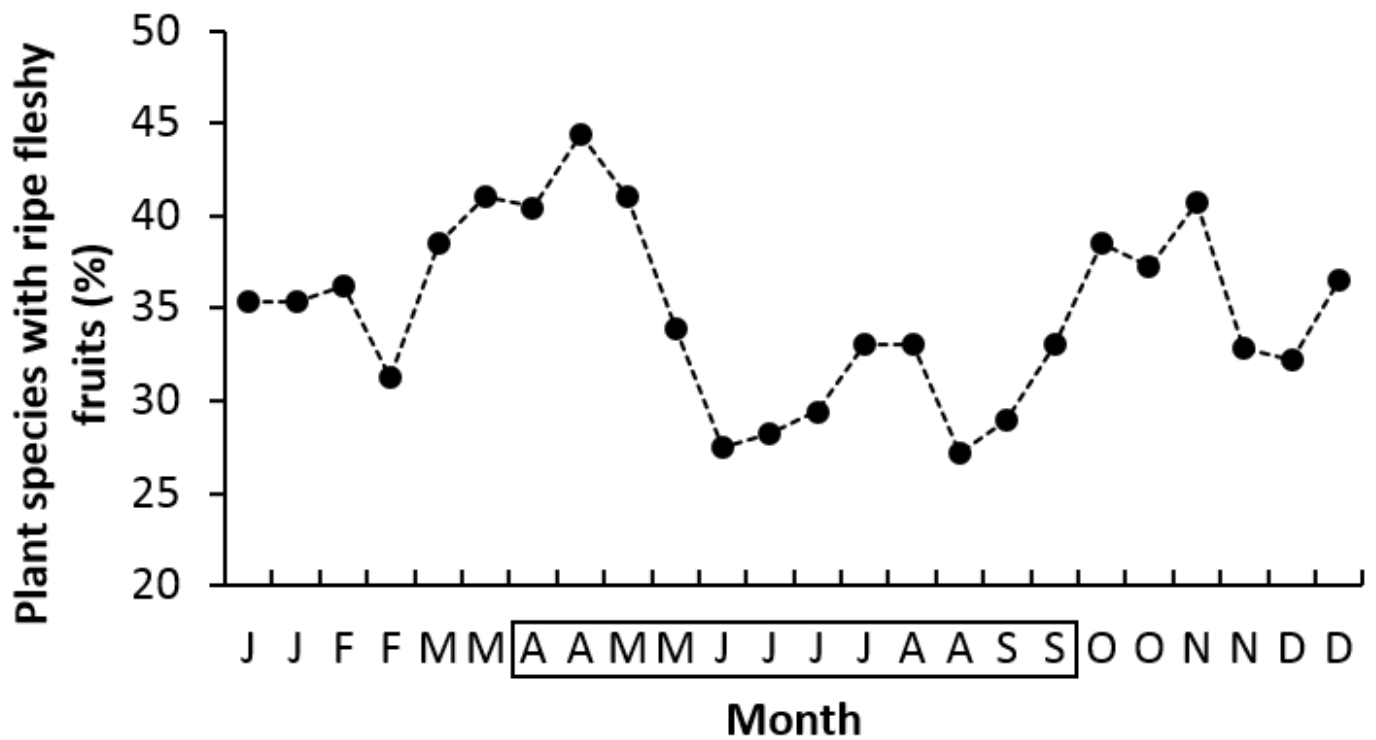


Figure 2. Availability of ripe fleshy fruits in the study area. Fruiting data were collected biweekly from March 2010 to February 2012 from 78 tree species in Ilha Solteira, São Paulo, Brazil (data and details in Silva & Melo 2013). The frame around April and September indicates the dry season.

Table 1. Previous records of species of toucans (Ramphastidae) eating flowers.

Toucan species	Plant species	Source
Chestnut-eared Aracari – <i>Pteroglossus castanotis</i> (Gould, 2834)	Fabaceae – <i>Erythrina fusca</i>	Parrini & Raposo (2010)
Emerald Toucanet – <i>Aulacorhynchus prasinus</i> (Gould, 1834)	Dilleniaceae – <i>Saurauia</i> spp.	Riley & Smith (1986)
	Ericaceae – <i>Mcclenia</i> spp.	
	Fabaceae – <i>Erythrina lanceolata</i>	
Pale-mandibled Aracari – <i>Pteroglossus erythropygius</i> (Gould, 1843)	Malvaceae – <i>Pseudobombax</i> sp.	Berg (2000)
Saffron Toucanet – <i>Pteroglossus bailloni</i> (Vieillot, 1819)	Combretaceae – <i>Combretum</i> sp.	Galetti et al. (2000)
	Solanaceae – <i>Solanum mauritianum</i>	
Toco Toucan – <i>Ramphastos toco</i> (Stadius Muller, 1776)	Bignoniaceae – <i>Handroanthus heptaphyllus</i>	Ragusa-Netto (2006)
	Fabaceae – <i>Erythrina fusca</i>	Parrini & Raposo (2010)

1999) in which toucans eat readily available alternative food items in response to the scarcity of their major food item, i.e., fleshy fruits. It also corresponds to the general hypothesis that frugivorous birds might resort to flowers during fleshy fruit shortages in the driest period (Terborgh 1986). Furthermore, aside from providing an alternative source of nutrients and energy, the treetops of blooming trees can also constitute safe places for Toco Toucans seeking water (*sensu* Silva et al. 2015), a scarce resource in the dry season (Janzen 1980).

Since Riley & Smith (1986) observed flower eating by a toucan species for the first time, there have been very few reports of toucans feeding on flowers (Table 1). My records

almost doubled the number of plant species whose flowers are reportedly consumed by toucans. However, the total number remains limited: up to 15 plant species consumed by five toucan species. It remains to be object of further study whether toucans eating flowers is an unusual phenomenon or if it has been under reported or under observed. Toucan species usually forage in the forest canopy, which makes it difficult to obtain data on their diet preferences (Terborgh et al. 1990, Sick 1997). Although they are most common in rainforests (Sick 1997), some toucan species inhabit regions with more erratic rainfall (Sick 1997, Ragusa-Netto 2008), and some have been seen inhabiting anthropogenic environments (Goulart et al. 2011, Peters & Nibbelink 2011, Santos

& Ragusa-Netto 2013). The combination of dry and anthropogenic characteristics may result in lower food availability. For example, in addition to the natural fluctuation in fruiting (Janzen 1986, van Schaik et al. 1993), fruits are usually available in scarce numbers and isolated patches, respectively, in the human-dominated landscape (Isaac & Cowlshaw 2004). I hope that this report encourages other researchers to seek and report observations of flower-eating toucans in order to fully understand the importance of this resource to toucans in drier and anthropogenic regions.

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