

# Birds as potential pollinators of the *Spathodea nilotica* (Bignoniaceae) in the urban environment

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(With 1 figure)

## Abstract

Birds play crucial role on the pollination of many plants. However, little is known about the interactions between nectarivorous neotropical birds and exotic Angiosperms. *S. nilotica* is an exotic African plant widely used in Brazilian urban landscaping. However, it has been poorly studied in relation to its interactions with Neotropical birds. In this way, we studied the feeding nectar strategies and the interspecific antagonistic behaviours among nectarivorous Neotropical birds to verify the bird contributions to the *S. nilotica* pollination. The study was conducted from May 2008 to April 2011, but only in months of *S. nilotica* flowering (April to May). From 148 hours of sampling we identified 16 species feeding nectar on *S. nilotica*: 13 hummingbirds (Trochilidae), *Aratinga aurea* (Psittacidae), *Tangara palmarum* (Thraupidae) and *Coereba flaveola* (Coerebidae). *Eupetomena macroura* was the most frequent (96.88%), followed by *Chlorostilbon lucidus* (78.13%) and *Coereba flaveola* (59.38%). Most birds obtained nectar by punching at the base of the corolla, except for *A. aurea* that obtained the nectar by the upper opening of the petals in 100% of its visits, *Heliomaster furcifer* (95.65%), *F. fusca* (95%) and *A. nigricollis* (70.27%). Despite *E. macroura* also obtains nectar only by punching at the base of the corolla, it showed the highest level of legitimate visits. Antagonistic events were more frequent in *E. macroura* (58.65%), *Florisuga fusca* (11.04%) and *Amazilia fimbriata* (10.87%), being *E. macroura* dominant in all events. These results showed *E. macroura* plays an important role on this plant being the most important bird as a potential pollinator. Moreover, other birds contribute partially to the *S. nilotica* pollination. Most probably it is a result of recent Neotropical bird interactions with this African plant.

**Keywords:** nectarivorous Neotropical birds, african-tulip-tree, nectar exploitation.

## Aves como potenciais polinizadoras de *Spathodea nilotica* (Bignoniaceae) em ambiente urbano

### Resumo

As aves representam um grupo ecologicamente importante nas interações animais-flores na região Neotropical, onde desempenham respeitável papel na polinização de diversas angiospermas. Entretanto, pouco se conhece sobre a organização das comunidades e as interações bióticas entre animais/plantas em ambientes urbanos. Como exemplo, *S. nilotica*, planta exótica africana amplamente explorada para fins de paisagismo urbano, têm sido pouco estudada em relação às suas interações com aves. Assim, analisamos quais espécies de aves visitam *S. nilotica*, o tipo de exploração dos recursos nectarívoros pelas aves e o comportamento antagonístico intra e interespecífico das aves que visitaram esta planta. O estudo foi realizado de maio de 2008 a abril de 2011, nos meses de florescimento de *S. nilotica* (abril a maio). Foram totalizadas 148 horas de amostragem e identificadas 16 espécies se alimentando de néctar, 13 beija-flores (Trochilidae), *Aratinga aurea* (Psittacidae), *Tangara palmarum* (Thraupidae) e *Coereba flaveola* (Coerebidae). As aves mais frequentes foram *Eupetomena macroura* (96,88%), *Chlorostilbon lucidus* (78,13%) e *Coereba flaveola* (59,38%). A frequência de visitas foi maior no período matutino, exceto para *E. macroura*, *H. longirostris* e *T. palmarum*. A maioria das aves obteve o néctar através de rompimento na base da corola (orifícios), com exceção de *A. aurea* que obteve néctar pela abertura superior entre as pétalas em 100% de suas visitas e *H. furcifer* (95,65%), *F. fusca* (95%) e *A. nigricollis* (70,27%). Eventos antagonísticos foram mais acentuados em *E. macroura* (58,65%), *Florisuga fusca* (11,04%) e *Amazilia fimbriata* (10,87%), sendo *E. macroura* dominante durante os eventos. Os resultados demonstram que *E. macroura* é a ave dominante em *S. nilotica* e a que se apresenta com maior potencial para sua polinização. Entretanto, as outras aves contribuem parcialmente como potenciais polinizadoras de *S. nilotica*. Muito provavelmente isto é resultado de uma interação recente entre as aves neotropicais e esta planta Africana.

**Palavras-chave:** aves nectarívoras, tulipeira, exploração de néctar.

## 1. Introduction

Urbanisation modifies significantly both the physical structure and biotic habitat and it may affect many ecological processes. As a result of human intervention, the urban landscape generally has fragmented into a mosaic of different environments and both vegetation structure and floristic composition usually differ from that was originally present (Argel-de-Oliveira, 1996).

Birds, especially hummingbirds, represent a group numerically and ecologically dominant in flower-animal interactions in the Neotropics (Stiles, 1981). They are also very successful in urban areas (Gilbert, 1989; Marsluff et al., 2001) where they play an important role in the pollination of many flowering plants (Mendonça and Anjos, 2003). However, there are few studies conducted in urban areas of the Brazilian Biomes (Mendonça and Anjos, 2003).

Ornithophilous plants are characterised by the presence of diurnal anthesis flowers, odourless, of conspicuous coloration, with the production of large amounts of nectar, but low concentration of sugars in their nectarines. In addition their nectarines are not close to the fertile parts, normally exposed (Faegri and Pijl, 1979). However, the majority of flower-animal interaction studies has been focussed on areas that have been little disturbed (Ragusa-Neto, 2002; Antunes 2003; and Machado et al., 2007), and as a result, little is known about the organisation of communities and biotic interactions between plants and animals in urban environments (Mendonça and Anjos, 2005). The understanding of these issues supports the choice of more effective measures for bird conservation, which in turn ensures the reproduction of visited plants and the supply of food resources needed (Piratelli, 1997).

*Spathodea nilotica* is an exotic plant, originated in Central Africa. It is typical from warm regions and it is widely introduced in Brazilian urban environments (Lorenzi et al., 2003). Nogueira-Neto (1970) noted that since *S. nilotica* was introduced into Brazil, this has been the cause of substantial mortality of native bees.

Exotic plants used in ornamental gardens are exploited by birds and they can contribute to the persistence of many bird species, including migratory ones (Corlett, 2005; Mendonça and Anjos, 2005). However, studies are rare on the ecological interactions between *S. nilotica* and Neotropical birds (Mendonça and Anjos, 2005). So further investigations are necessary on how Neotropical birds explore the nectarivorous resources from *S. nilotica*.

Thus, we recorded the birds that visited *S. nilotica* to: a) describe how the nectarivorous resources are exploited by birds; b) determine if these birds are potential pollinators of the *S. nilotica* and c) observe the bird territoriality and domination at flowering periods.

## 2. Material and Methods

We conducted this study in different urban regions in the Três Lagoas municipality, Mato Grosso do Sul state.

The climate is tropical humid, AW type, according to Köppen, with the dry season from April to September and wet season, from October to March. There is no significant variation on temperature and the annual medial temperature is 24.1 °C (Pinto, 1994).

We observed five specimens of *S. nilotica* (Bignoniaceae) during tree flowering periods: May 2008, February, May and June 2009 and April 2011. Observations were made during daytime in two periods: 1) morning, from 6:00 to 9:00; 2) afternoon, from 14:00 to 17:00. The rainy days were discarded.

The birds were observed with binoculars (8x25 and 8x42). We first recorded the bird species, then we verified how it exploited the resources of the flower according to Machado (2009): a) the legitimate visit is characterised by contacting the reproductive organs of the plant and it leads the pollen attached to the beak or to the dorsal or ventral portions of the head b) the illegitimate visits, in which the bird pierces the flower at the base of the corolla, absorbing the nectar directly without contact with the pollen. We considered only the legitimate visits in order to identify those birds that would be potential pollinators on *S. nilotica*.

Finally, we observed whether there were intra and interspecific antagonistic interactions. The interaction is considered by the attacks and/or persecution, but the vocalisations are ignored, as proposed by Machado (2009). This approach is important to point out the most dominant birds that explore the *S. nilotica* nectar in order to determine their potential importance in pollination.

For bird identification we used field guides (Dunning 1987, Develey and Endrigo, 2004; Erize et al., 2006). For the plant identification we used Lorenzi (2003). The classification and taxonomy of the bird species followed the CBRO list (2011).

We calculated the frequency of occurrence of species, inter and intraspecific antagonistic behaviour, and foraging strategy of nectarivorous birds on *S. nilotica*.

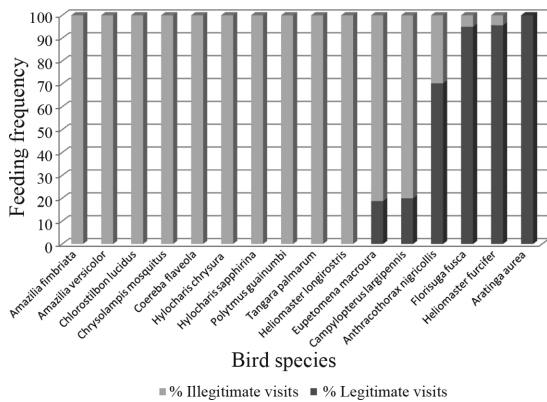
## 3. Results

We performed 148 hours of observation, 74 in the morning and 74 in the afternoon, over 32 days. We recorded 16 nectarivorous bird species exploiting *S. nilotica*. They belong to four families: a) Psittacidae: *Aratinga aurea* (Gmelin, 1788); b) Trochilidae: *Amazilia fimbriata* (Gmelin, 1788), *A. versicolor* (Vieillot, 1818), *Anthracothorax nigricollis* (Vieillot, 1817), *Campylopterus largipennis* (Boddaert, 1783), *Chlorostilbon lucidus* (Shaw, 1812), *Chrysolampis mosquitus* (Linnaeus, 1758), *Eupetomena macroura* (Gmelin, 1788), *Florisuga fusca* (Vieillot, 1817), *Heliomaster fuscifer* (Shaw, 1812), *H. longirostris* (Audebert and Vieillot, 1801), *Hylocharis chrysura* (Shaw, 1812), *H. saphirina* (Gmelin, 1788), *Polytmus guainumbi* (Pallas, 1764); c) Thraupidae: *Tangara palmarum* (Wied, 1823) and d) Coerebidae: *Coereba flaveola* (Linnaeus, 1758).

*Eupetomena macroura* was the most frequent species (51 events of visits = 20.39%), followed by *C. lucidus*

with 33 events (16.45%) and *C. flaveola* with 25 events (12.50%) (Table 1). Most birds were more frequent in the morning, but *E. macroura* visited the periods equally (49.02% and 50.98%, respectively). On the other hand, *T. palmarum* and *H. longirostris* were only observed in the afternoon (Table 1).

Only six species were observed performing legitimate visits: *A. aurea* 100% of legitimate visits, followed by *H. furcifer* (95.65%), *F. fusca* (95%), *A. nigricollis* (70.27%), *C. largipennis* (20%) and *E. macroura* (18.76%) (see Figure 1). *A. aurea* and *A. nigricollis* presented as potential efficient pollinators of *S. nilotica* by mostly extracting the nectar through the opening of the corolla. They reached the nectar by entering their entire



**Figure 1** - Frequency of feeding on nectar according to the bird foraging strategy.

body inside of the corolla. On the other hand, *F. fusca* and *H. furcifer* present both body and beak elongated enough to reach the bottom of the corolla, where the nectar is found.

*E. macroura* was presented in 58.65% of all antagonistic interactions recorded, followed by *F. fusca* and *A. fimbriata* to 11.04% and 10.87%, respectively. Seven species (*A. nigricollis*, *C. largipennis*, *C. lucidus*, *H. chrysura*, *H. sapphirina*, *P. guainumbi* and *T. palmarum*) showed only interspecific behaviour. *E. macroura* and *C. flaveola* showed the higher rates of intraspecific agonistic behaviour (52.81%) and (75%) respectively (Table 2).

According to the total antagonistic interactions, *E. macroura* (n = 356), *F. fusca* (n = 67) and *A. fimbriata* (n = 66) were the most aggressive species. *A. fimbriata* unlike *E. macroura*, was not successful in warding off the intruders (*F. fusca* and *A. nigricollis*). Subordinate species (*C. lucidus*, *A. fimbriata* and *H. furcifer*) took the opportunity while the dominant species was absent or performing another activity.

*E. macroura* is the main territorial bird of *S. nilotica*. In addition it is considered resident since it was observed in the same and specific locations in the flowering period of *S. nilotica*. It was observed in 97% of the sample days, and it accounts for 20.39% of the total visits. Notable is the strong territoriality of this species. It was possible to observe a tree being divided and defended into different *S. nilotica* stratification by *E. macroura* residents. *E. macroura* was observed perched on the flowers to feed on nectar or in its petiole. In warmer periods of day, *E.*

**Table 1** - Frequency of bird visitation in *Spathodea nilotica* according to the period of day and to the visits for all days sampled. The bird sequence follows the frequency percentage.

Species	Morning (%)	Afternoon (%)	Total of visits (%)
<i>Eupetomena macroura</i>	49.02	50.98	20.39
<i>Chlorostilbon lucidus</i>	63.64	36.36	16.45
<i>Coereba flaveola</i>	64.00	36.00	12.50
<i>Amazilia fimbriata</i>	55.56	44.44	11.18
<i>Anthracothorax nigricollis</i>	57.14	42.86	10.53
<i>Florisuga fusca</i>	85.71	14.29	8.55
<i>Amazilia versicolor</i>	75.00	25.00	3.95
<i>Heliomaster furcifer</i>	55.56	44.44	3.29
<i>Polytmus guainumbi</i>	75.00	25.00	2.63
<i>Hylocharis sapphirina</i>	100.00	-	2.63
<i>Campylopterus largipennis</i>	66.67	33.33	1.97
<i>Hylocharis chrysura</i>	100.00	-	1.97
<i>Tangara palmarum</i>	-	100.00	1.32
<i>Aratinga aurea</i>	100.00	-	1.32
<i>Chrysolampis mosquitus</i>	100.00	-	0.66
<i>Heliomaster longirostris</i>	-	100.00	0.66

**Table 2** - Frequency of the intra/interspecific antagonistic interactions among birds on *Spathodea nilotica*. The bird sequence follows the frequency percentage.

Species	Intraspecific (%)	Interspecific (%)	Total of events (%)
<i>Eupetomena macroura</i>	52.81	47.19	58.65
<i>Florisuga fusca</i>	16.42	83.58	11.04
<i>Amazilia fimbriata</i>	16.67	83.33	10.87
<i>Chlorostilbon lucidus</i>	-	100.00	6.43
<i>Coereba flaveola</i>	75.00	25.00	3.30
<i>Heliomaster furcifer</i>	18.75	81.25	2.64
<i>Anthracothorax nigricollis</i>	-	100.00	2.47
<i>Hylocharis sapphirina</i>	-	100.00	1.81
<i>Amazilia versicolor</i>	10.00	90.00	1.65
<i>Hylocharis chrysura</i>	-	100.00	0.49
<i>Campylopterus largipennis</i>	-	100.00	0.33
<i>Polytmus guainumbi</i>	-	100.00	0.16
<i>Tangara palmarum</i>	-	100.00	0.16

*macroura* was perched on tree branches just defending its territory from other invaders. In general, this behaviour decreased as soon as the intensity of heat increased.

#### 4. Discussion

Mendonça and Anjos (2005) studied hummingbirds in urban areas in southern Brazil and they recorded seven species visiting *S. nilotica*, five in common with our study (*A. nigricollis*, *C. lucidus*, *E. macroura*, *F. fusca* and *H. chrysura*). Machado (2009) observed eight hummingbirds exploiting the resources of Bigoniaceae trees, three of which were also observed in *S. nilotica* (*C. lucidus*, *C. mosquitus* and *E. macroura*).

Antunes (2003) noted that species of dominant hummingbirds in eucalyptus flowers were more frequent in the morning and the non-dominant ones in the afternoon. However this is not in agreement if we consider *E. macroura*. This discrepancy was probably due to the fact that *E. macroura* is resident (see results).

Feinsinger and Colwell (1978) suggested that the hummingbirds are traveller species that use the spaces left by others. In addition, they are opportunistic, stealing the nectar when the defender is absent. The data obtained in *S. nilotica* corroborate this hypothesis, mainly in relation to *C. lucidus*, *A. fimbriata* and *H. furcifer* (see results). This behaviour was also observed by Antunes (2003).

Machado et. al. (2007) observed all hummingbirds in the Chapada Diamantina (Bahia state, Brazil) making legitimate visits to flowers, including plants such as the Bignoniaceae *Jacaranda irwinii* (AH Gentry). It indicates they probably disperse the pollen of this species. In this study, most species only pillaged nectar, not pollinating the plant. The same was observed for *S. nilotica* by Mendonça and Anjos (2005). Thus, the most frequently

species, such as *E. macroura*, *C. lucidus* and *C. flaveola* damaged the reproductive strategy of this plant, not constantly plundering nectar in exchange for offering a great chance of spreading pollen. As a result, most species only pillaged nectar without contributing to the reproductive strategy of the plant. Most probably it is a result of recent Neotropical bird interactions with this African plant.

Despite the low number of contacts, *A. aurea*, *A. nigricollis*, *F. fusca* and *H. furcifer* presented as possible efficient pollinators of *S. nilotica* by mostly extracting the nectar through the opening of the corolla. The large flocks of *A. aurea* move over long distances to new areas in search of nectar. This species made frequent inter-tree movements and it promotes cross-pollination (Ragusa-Netto and Fecchio, 2006; Silva, 2008). Although their movements are not well understood, *A. nigricollis*, *F. fusca* and *H. furcifer* are local or seasonal migrant hummingbirds that visit thousands of flowers per day promoting efficient pollination (Sick, 1997).

Apparently *E. macroura* seems to be a “harmful species” to the reproductive strategy of *S. nilotica*. However this species performed legitimate visits in 18.7% of occasions (103 of 549 contacts observed). It exceeds in high quantity of the others legitimate visitors, as *F. fusca*, *A. nigricollis* and *H. furcifer*.

Mendonça and Anjos (2005) observed that most of the birds showed territorial behaviours as observed in this paper. The *F. fusca*, together with *A. nigricollis*, did not show territoriality in *S. nilotica*, but Mendonça and Anjos (2006) observed that *F. fusca* was the main bird to show antagonistic behaviour among bird species observed in *Erythrina speciosa* (Fabaceae). Most probably this species was less aggressive in the present study because it is migratory and *E. macroura* is an extremely territorial bird already resident in *S. nilotica*. Although there was little visitation in most species, the interspecific antago-

nistic behaviour was predominant, except for *E. macroura* and *C. flaveola* (see results). This highest rate in *E. macroura* is explained by the fact this species is extremely territorial and also it is the main consumer of the *S. nilotica* nectar. In relation to *C. flaveola* perhaps *E. macroura* does not identify this species as a major threat to the consumption of nectar of *S. nilotica*, since different strategies to exploit nectar may reduce competition between them, as suggested by Dreisig (1997). Occasionally *E. macroura* was observed attacking other birds of major weight, but they do not make use of nectarivores resources at all, such as *Passer domesticus* (Linnaeus, 1758) and *Zenaid a auriculata* (Des Murs, 1847).

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### References

- ANTUNES, AZ., 2003. Partilha de néctar de *Eucalyptus* spp., territorialidade e hierarquia de dominância em beija-flores (Aves: Trochilidae) no sudeste do Brasil. *Ararajuba*, vol. 11, no. 1, p. 39-44.
- ARGEL-DE-OLIVEIRA, MM., 1996. Aves urbanas. In VIELLIARD, JM., SILVA, ML. and SILVA, WR. (Eds.). *Anais V Congresso Brasileiro de Ornitologia, Campinas*. p. 151-162.
- COMITÊ BRASILEIRO DE REGISTROS ORNITOLÓGICOS, 2011. *Listas das aves do Brasil*. 10ª Edição, 25/1/2011. Available from: <http://www.cbro.org.br>. Access in: 21 sept. 12.
- CORLETT, RT., 2005. Interactions between birds, fruit bats and exotic plants in urban Hong Kong, South China. *Urban Ecology*, vol. 8, p. 275-283.
- DEVELEY, PF. and ENDRIGO, E., 2004. *Guia de campo das aves da grande São Paulo*. São Paulo: Aves e Fotos. 295 p.
- DREISIG, H., 1997. Why do some foragers perch and other hover while probing flowers? *Evolutionary Ecology*, vol. 11, p. 543-555.
- DUNNING, JS., 1987. *South american birds*. Newtown Square: Harrowood Books. 351 p.
- ERIZE, F., MATA, JR. and RUMBOLL, M., 2006. *Birds of South America*. Princeton: Princeton University Press. 384 p.
- FAEGRI, K. and PIJL, L., 1979. *The principles of pollination ecology*. New York: Pergamon Press. 244 p.
- FEINSINGER, P. and COLWELL, RK., 1978. Community organization among neotropical nectar-feeding birds. *American Zoologist*, vol. 18, p. 779-795.
- GILBERT, OL., 1989. *The ecology of urban habitats*, New York: Chapman and Hall, 369 p.
- LORENZI, H., SOUZA, HM., TORRES, MAV. and BACHER, LB., 2003. *Árvores exóticas no Brasil. Madeiras, ornamentais e aromáticas*. Nova Odessa, Brasil: Instituto Plantarum de Estudos da Flora. 368 p.
- MACHADO, CG., 2009. Beija-flores (Aves: Trochilidae) e seus recursos florais em uma área de caatinga da Chapada Diamantina, Bahia. *Revista Brasileira de Zoologia*, vol. 26, no. 2, p. 255-265.
- MACHADO, CG., COELHO, AG., SANTANA, CS. and RODRIGUES, M., 2007. Beija-flores e seus recursos florais em uma área de campo rupestre da Chapada Diamantina, Bahia. *Revista Brasileira de Ornitologia*, vol. 15, no. 2, p. 267-279.
- MARSLUFF, JM., BOWMAN, R. and DONNELLY, R., 2001. *Avian ecology and conservation in an urbanizing world*. Boston: Kluwer Academic Publishers. 585 p.
- MENDONÇA, LB. and ANJOS, L., 2003. Bird flower interactions in Brazil: a review. *Ararajuba*, vol. 11, no. 2, p. 195-205.
- . 2005. Beija-flores (Aves, Trochilidae) e seus recursos florais em uma área urbana do sul do Brasil. *Revista Brasileira de Zoologia*, vol. 22, no. 1, p. 51-59.
- . 2006. Feeding behavior of humminbirds and perching birds on *Erythrina speciosa* Andrews (Fabaceae) flowers in an urban area, Londrina, Paraná, Brazil. *Revista Brasileira de Ornitologia*, vol. 23, no. 1, p. 42-49.
- NOGUEIRA-NETO, P., 1970. *A criação de abelhas indígenas sem ferrão (Meliponinae)*. São Paulo: Tecnapis. 365 p.
- PINTO, MN., 1994. *Cerrado*. Brasília: Editora Universidade de Brasília. 681 p.
- PIRATELLI, AJ., 1997. Comportamento alimentar de beija-flores em duas espécies de *Hippeastrum* HERB. (Amaryllidaceae). *Brazilian Journal of Biology*, vol. 57, no. 2, p. 261-273.
- RAGUSA-NETO, J., 2002. Exploitation of *Erythrina dominguezii* Hassl. (Fabaceae) nectar by perching birds in a dry forest in western Brazil. *Brazilian Journal of Biology*, vol. 62, no. 4B, p. 877-883.
- RAGUSA-NETTO, J. and FECCHIO, A. 2006. Plant food resources and the diet of a parrot community in a gallery forest of the south Pantanal (Brazil). *Brazilian Journal of Biology*, vol. 66, p. 1021-1032.
- STILES, FG., 1981. Geographical aspects of bird-flower co-evolution, with particular reference to Central America. *Annals of the Missouri Botanical Garden*, vol. 68, p. 323-351.
- SICK, H., 1997. *Ornitologia brasileira*. Rio de Janeiro: Nova Fronteira. 912 p.
- SILVA, PA., 2008. Periquitos (*Aratinga aurea* e *Brotogeris chiriri*, Psittacidae) como potenciais polinizadores de *Mabea fistulifera* Mart. (Euphorbiaceae). *Revista Brasileira de Ornitologia*, vol. 16, no. 1, p. 23-28.