Honeydew foraging by birds in an Atlantic Forest fragment of Minas Gerais State, Brazil

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Abstract: Honeydew foraging by birds has been extensively documented in recent years. However, this interaction has been poorly documented in Brazil, with predominance of few species of birds foraging only in *Mimosa scabrella* trees. With the objective of describing the behavior of birds interacting with scale insects associated with trees, we conducted a study at the Serra de São José, Tiradentes, in the State of Minas Gerais, Brazil. Observations were recorded from June to July 2012. We observed 13 species of birds feeding on honeydew scale insects, eight never previously recorded. We observed individuals using aerial and surface maneuvers to collect the honeydew on the branches or reaching the droppings below the branches. These species were observed foraging individually, in pairs and also in large groups. Our results suggest that honeydew excretion from scale insects associated with *Pseudopiptadenia leptostachya* trees represents an important energy source for local birds as observed in fragments of Atlantic Forest in the Minas Gerais State, southeast region of Brazil.
Keywords: *trophic connections, excretion, insects, behavior maneuvers, Serra de São José.*

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Resumo: O uso de excreções líquidas açucaradas por aves tem sido amplamente divulgado nos últimos anos. No entanto, estudos acerca desta interação são escassos no Brasil, sendo que os poucos existentes relatam apenas algumas espécies de aves forrageando a excreção de insetos presentes em uma única espécie de árvore (*Mimosa scabrella*). Com o objetivo de descrever o comportamento de aves interagindo com insetos excretores de líquidos açucarados associados com árvores, nós conduzimos um estudo na Serra de São José, município de Tiradentes em Minas Gerais, Brasil. Nossas observações foram feitas de Junho a Julho de 2012 e 13 espécies de aves foram registradas forrageando a excreção, sendo que oito delas nunca haviam sido anteriormente registradas envolvidas neste tipo de interação. Nós observamos indivíduos usando manobras aéreas e na superfície das árvores para coletar a excreção nos galhos ou alcançar gotículas debaixo dos troncos. Estas espécies foram observadas forrageando individualmente, em pares ou em grandes grupos. Nossos resultados sugerem que a excreção açucarada excretada por insetos associados com árvores mamica-de-porca (*Pseudopiptadenia leptostachya*), representa uma importante fonte de energia para as aves, conforme observado em fragmentos de mata Atlântica no Estado de Minas Gerais, sudeste do Brasil.
Palavras-chave: *conexões tróficas, excreção, insetos, manobras comportamentais, Serra de São José.*

Introduction

Honeydew foraging by birds has been extensively documented as a result of an important interaction with scale insects (Hemiptera, Coccoidea) (Gamper & Koptur 2010, Beggs 2001, Gaze & Clout 1983, Greenberg et al. 1993, Jirón & Salas 1975, Koster & Stoewesand 1973, Latta et al. 2001, Murphy & Kelly 2003, Paton 1980, Woinarski 1984). Scale insects need large amounts of phloem to fulfill their nutrient demands and therefore excrete large amounts of honeydew, which is sugary waste rich in carbohydrates and amino acids. The excretion is done through small drops of honeydew at the end of a long anal filament (Williams & Williams 1980). In some ecosystems, the use of honeydew by ants, wasps and bees has been recorded (Bach 1991, Moller & Tilley 1989, Didham 1993). The use of honeydew may represent the primary source of carbohydrates to a large array of wildlife and may improve trophic connections (Grant & Beggs 1989).

In Brazil honeydew foraging by birds has been poorly documented, with predominance of scale insects associated with bracatinga trees (*Mimosa scabrella* Benth). Species of hummingbirds such as *Leucochloris albicollis* (Vieillot, 1818) and *Chlorostilbon lucidus* (Shaw, 1812) have been recorded foraging on scale insects mostly in the Santa Catarina State, south region of the country (Reichholf & Reichholf 1973). Besides hummingbirds, groups of other species of birds, such as *L. albicollis*, *Parula pitiayumi* (Vieillot, 1817), *Tangara peruviana* (Desmarest, 1806), *Stephanophorus diadematus* (Temminck, 1823), *Tachyphonus coronatus* (Vieillot, 1822), *Saltator similis* (d'Orbigny & Lafresnaye, 1837) and *Zonotrichia capensis* (Müller, 1776) have been recorded foraging in one bracatinga tree of approximately 12 meters, in the northern area of Santa Catarina State (Sick 1988, L.A. Rosário pers. comm.). In another occasion, a group comprised of eight maroon-bellied parakeets (*Pyrrhura frontalis,* Vieillot, 1817), was also recorded in one *Mimosa scabrella* tree in the highland forests of the same State (Rosário 1996). Our objective was to describe the behavior of birds interacting with scale insects associated with trees in the southeastern region of Brazil and discuss the importance of this interaction.

Material and Methods

This study was conducted at the Serra de São José, a mountain range near the town of Tiradentes, in the State of Minas Gerais, Brazil. The region is located in the ecotone of the Cerrado and semi-deciduous portions of the Atlantic Forest (Oliveira-Filho & Machado 1993). The vegetation is very diversified (Carvalho et al. 1994), originally comprised by a complex mosaic of forest patches, Cerrado and opens fields of campos rupestres (Eiten 1982). The tropical climate of the region is characterized by rainy summers and dry winters. Mean annual precipitation and temperature at the base of the mountain range were 1.514-1.588 mm and 19,3- 20,1 °C respectively, whereas at the upper montane area were 1.536-1.605 mm and 14,8-18,6 °C (Pereira et al. 2007). Approximately 70% of the rains occur between November and February.

The fragment where observations were recorded was located at an altitude of approximately 1000 meters (21° 6' 6.79" S and 44° 10' 53.30" W) in a semi-deciduous fragment of forest along the southern border of the study area. The fragment was comprised by medium-sized trees of approximately 16 meters in the interior portion of the semi-deciduous forest.

Observations were recorded from June (15th, 17th, 18th, 19th and 26th) to July (7th), 2012. The number of birds visiting the trees, species and total time spent in the tree by each bird, were recorded during 3 hours observation periods. Observations were made using binoculars (Bushnell 8×40 mm) during the first hours of the morning (7:00-10:30 hours) and between 15:00-17:30 hours in the afternoon. All the birds visiting the trees were followed visually to determine whether they were feeding on scale insect honeydew or performing another sort of behavior. Feeding behaviors or intraspecific interactions (chasing behavior or physical contact) not direct related to honeydew feeding were recorded by taking photographs (Canon Powershot SX30) of birds. We assumed that each picture corresponded to one independent event of feeding behavior since individual identification of birds was not accomplished visually. To guide our interpretation of different behaviors performed by the birds, we use descriptions suggested by Volpato & Mendonça-Lima (2002), based on Remsen & Robinson (1990).

Results

We recorded a total of 16 bird species visiting trees during our six different observation periods (four periods during the mornings of 15, 17, 26 of June, and 07 of July, and two in the afternoons of 18 and 19 of June). Of those 16 bird species, 13 (81%) were observed feeding on honeydew scale insects (Table 1). All individual observation trees were determined to be *Pseudopiptadenia leptostachya* (Benth). The other three species were visiting the trees to either feed on other species of insects (*Florisuga fusca* Vieillot, 1817, and *Sittasomus griseicapillus* Vieillot, 1818) or just resting (*Amazilia versicolor* Vieillot, 1818). All bird species were considered resident to the study area.

Honeydew feeding behavior differed among observed birds. On four periods (15, 17, 18 and 26 of June) we observed single individuals of five species (*Leucochloris albicollis*, *Amazilia lacteal,* Lesson, 1832, *Thalurania glaucopis* Gmelin, 1788*, Tangara cyanoventris* Vieillot, 1819, and *Chlorostilbon lucidus*) using sally-hover aerial maneuvers for feeding on honeydew. Among these species, only *Leucochloris albicollis* was observed foraging in large numbers of approximately twelve individuals.

Other eight species of birds were observed foraging honeydew using surface maneuvers either gleaning to collect the honeydew on the branches or reaching the droppings below the branches. These species were observed on three periods (17 and 26 of June and 07 of July) foraging individually (*Tangara palmarum* Wied, 1823, *Dacnis*

Table 1. Bird species visits to scale insects on mamica-de-porca trees in a semi-deciduous fragment of forest at the Serra de São José, Minas Gerais State, Brazil (June to July, 2012). The use of honeydew is indicated by Y = yes, N = no. Behavior status (A = aerial, S= surface).

Species	Use of honeydew	Behavior type
Leucochloris albicollis	Y	A
Chlorostilbon lucidus	Y	A
Parula pitiayumi	Y	S
Tachyphonus coronatus	Y	S
Amazilia lactea	Y	A
Thalurania glaucopis	Y	A
Tangara sayaca	Y	S
Tangara cayana	Y	S
Tangara cyanoventris	Y	A
Coereba flaveola	Y	S
Tangara palmarum	Y	S
Dacnis cayana	Y	S
Hemithraupis ruficapilla	Y	S
Florisuga fusca	N	-
Sittasomus griseicapillus	N	-
Amazilia versicolor	N	-

cayana Linnaeus, 1766, *Tachyphonus coronatus, Parula pitiayumi*, *Tangara cayana* Linnaeus, 1766, and *Coereba flaveola* Linnaeus, 1758), in pairs (*Tangara sayaca* Linnaeus, 1766, and *Hemithraupis ruficapilla* Vieillot, 1818), in groups of three individuals being two adults and one young (*Tangara sayaca*) or groups of approximately ten individuals (*Tangara cyanoventris*).

Three other species were observed foraging insects either on the canopy (*Florisuga fusca, Sittasomus griseicapillus*) or on the understory (*Amazilia versicolor*) of *Pseudopiptadenia leptostachya* trees. However we could not confirm the foraging of honeydew by these species. In addition to bird species, we observed a large amount of bees (*Trigona* sp.) feeding on honeydew on the 18 of June. During this observation period, we did not record birds foraging on honeydew while bees were present at the trees.

Discussion

Our results show high incidence of movement among local birds towards *Pseudopiptadenia leptostachya* trees for foraging honeydew. These results suggest that honeydew excretion represents an important energy source for local birds. This fact seems to be supported by our observations of approximately 12 birds of the same species feeding at the same time and a total of 13 different species foraging along six different observation periods.

Honeydew excretion is considered an important carbohydrate source for several animals (Gaze & Clout 1983, Grant & Beggs 1989) because it is more easily metabolized (almost totally) in comparison with other types of food, like invertebrates (approximately 70% of metabolization) (Bell 1990). Moreover, the cost of foraging on honeydew is lower than foraging for invertebrates, particularly those more difficult to find and capture (Murphy & Kelly 2003).

Hierarchy of dominance and spatial segregation have already been reported among Trochilidae (Antunes 2003). Indeed, larger individuals seem to dominate over areas with higher resource availability (Camfield 2006, Lara et al. 2009, 2011), while smaller species feed either on the top of the canopy or near to bottom of the trees´ bark (Lara et al. 2009, 2011). However, our results suggest that *Thalurania glaucopis*, which is a larger species than *Leucochloris albicollis and Amazilia lactea* (Sick 1988), was less abundant and fed only on the bottom portion of the trees bark. Although considered an aggressive species that dominate food resources (Persegona et al. 2009), it is commonly found inhabiting the understory or medium strata of the forest, while other species occupy the canopy (Parker III et al. 1996). This might explain the minimum contact among Trochilidae species during our study.

Our results show that birds presented two different types of behavior while foraging on honeydew. Birds either used aerial maneuvers or surface maneuvers. In the first case, birds normally performed sally-hover movements for foraging while in the second case they gleaned to collect the honeydew on the branches or reached the droppings below the branches. While the Apodiformes performed only aerial maneuvers to forage on honeydew available on the branches or below them, all the Passeriformes but *Tangara cyanoventris*, fed exclusively through surface maneuvers. Therefore it seems that Passeriformes had a wider array of spatial behavior strategies while exploring honeydew.

Our results show a spatial interaction between birds and honeybees at least in one of our observation periods. While no antagonistic interactions between nectarivorous birds and insects such as wasps have been reported in previous studies (Gaze & Clout 1983), this bee species seems to represent an annoyance to humming bird species (Sick 1988).

Of the thirteen bird species recorded by this study, eight had not been previously recorded foraging on honeydew. There has been a known interaction between *Coereba flaveola* and scale insects (Coccoidea) in the subtropical dry forests at Dominican Republic (Latta et al. 2001). However, this is the first report recording the use of honeydew by this species in Brazil. For the species recorded in our study, previous reports indicate the use of honeydew by only *Leucochloris albicollis*, *Chlorostilbon lucidus* (Reichholf & Reichholf 1973, Sick 1988), *Parula pitiayumi* and *Tachyphonus coronatus* (Sick 1988). Moreover, all reports have occurred in the Santa Catarina State, in the south of Brazil and only in the *Mimosa scabrella* trees. Our results suggest that honeydew excretion associated with *Pseudopiptadenia leptostachya* trees represents an important energy source for local birds as observed in fragments of Atlantic Forest in the Minas Gerais State, southeastern region of Brazil.

Despite the apparent importance and relevance of the behaviors herein documented, studies about the use of honeydew by birds in Brazil are scant. Some aspects such as seasonality of honeydew foraging, identification of other insects involved in the interactions and behavioral aspects of the foraging are unknown and more studies should be performed to elucidate the importance of such resource for birds.

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