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SHORT NOTE

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HUMMINGBIRDS (TROCHILIDAE) AS FRUGIVORES: A REVIEW AND THE FIRST RECORDS FROM ARGENTINA

Facundo Xavier Palacio

Sección Ornitología, División Zoología Vertebrados, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Consejo Nacional de Investigaciones Científicas y Técnicas, Paseo del Bosque s/n, B1900FW, La Plata, Buenos Aires, Argentina.

E-mail: facundo_palacio@fcnym.unlp.edu.ar

Abstract · Hummingbirds (Trochilidae) are characterized by their specialized nectar-feeding behavior. However, fruit consumption by hummingbirds has been reported as an occasional behavior. I present a review on hummingbird frugivory in the Americas, along with the first records from Argentina. There have been 23 reports on fruit-hummingbird interactions belonging to 15 hummingbird species and 10 plant species, with records ranging from Chile to the United States. Two Gilded Hummingbirds (*Hylocharis chrysura*) and one Glittering-bellied Emerald (*Chlorostilbon lucidus*) foraging on blue passionflower (*Passiflora caerulea*) fruits were observed in northeastern Buenos Aires province, Argentina. Far from being rare events, hummingbirds accounted for a 23% of total bird-fruit interactions at my study area. My results suggest that fruit consumption by hummingbirds has a broad geographic range and may be more common than previously thought, at least in certain plant families, such as Cactaceae.

Resumen · Colibríes (Trochilidae) como frugívoros: una revisión y primeros registros para Argentina
Los colibríes (Trochilidae) se caracterizan por su comportamiento especializado en el consumo de néctar. Sin embargo, se ha reportado el consumo de frutos como un comportamiento ocasional. Presento una revisión de frugivoría por colibríes en las Américas, junto con los primeros registros para Argentina. Registré 23 interacciones fruto-colibrí para 15 especies de colibríes y 10 especies de plantas, con reportes desde Chile hasta Estados Unidos. Observé dos Picaflores Bronceados (*Hylocharis chrysura*) y un Picaflor Común (*Chlorostilbon lucidus*) alimentándose de frutos de Pasionaria (*Passiflora caerulea*) en el noreste de provincia de Buenos Aires, Argentina. Lejos de ser eventos raros, los colibríes representaron un 23% del total de interacciones planta-ave en el noreste de Buenos Aires. Mis resultados sugieren que el consumo de frutos por colibríes tiene un amplio rango geográfico y podría ser más común de lo que se piensa, al menos en ciertas familias de plantas, como cactáceas.

Key words: *Chlorostilbon lucidus* · Frugivory · *Hylocharis chrysura* · *Passiflora caerulea* · Seed dispersal · Trochilidae

INTRODUCTION

Hummingbirds (Trochilidae) are a conspicuous and well-studied New World clade of birds, which is characterized by specialized nectar-feeding habits (Schuchmann 1999). The long recognized mutualism between hummingbirds and plants (e.g., Stiles 1975, Waser 1978, Altshuler & Clark 2003, Fleming & Muchhala 2008) is evidenced by the fact that thousands of plant species rely exclusively on hummingbirds for pollination, which translates into a key ecosystem service (Whelan et al. 2008). Despite nectar represents an essential food resource, hummingbirds often supplement their diet with pollen and arthropods (Schuchmann 1999). Occasionally, they also feed on sap excavated by sapsucker woodpeckers (*Sphyrapicus* sp.) (Miller & Nero 1983, Estades 2003) or sugar-containing excretions of coccid insects (Reichoff & Reichoff 1973). More rarely, hummingbirds can consume fleshy fruits (Henderson 1927, Poulin et al. 1994, Ruschi et al. 2014). The degree and geographical extent of hummingbird fruit consumption, nevertheless, remain poorly known. Here I present a review on hummingbird frugivory, along with the first records from Argentina. Specifically, I report two observations of Gilded Hummingbirds (*Hylocharis chrysura*) and one observation of Glittering-bellied Emerald (*Chlorostilbon lucidus*) foraging on blue passionflower *Passiflora caerulea* (Passifloraceae) fruit.

METHODS

I conducted a literature search reporting fruit consumption by hummingbirds. I searched for studies published up to August 2018 by using the keywords “hummingbirds” and “frugivory” on Google Scholar database. The search results (728 articles) were screened to find reports of hummingbird frugivory. I then checked out the references of these studies to find earlier pub-

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Table 1. Hummingbird frugivory records in the Americas. Numbers between brackets indicate total observation hours (if available). Mean fruit diameters were taken from each study (if available).

Bird species	Number of observations (observation hours)	Plant species	Fruit diameter (mm)	Location	Source
Jamaican Mango (*Anthracothorax mango*)	Not given	*Stenocereus fimbriatus* (Cactaceae)	50	Jamaica	Lack (1976)
Cinnamon Hummingbird (*Amazilia rutila*)	7 (69 h)	*Cephalocereus maxonii* (Cactaceae)	45	Motagua Valley, Guatemala	Wendelken & Martin (1988)
Cinnamon Hummingbird (*Amazilia rutila*)	3 (50 h)	*Stenocereus eichlamii* (Cactaceae)	50	Motagua Valley, Guatemala	Wendelken & Martin (1988)
Plain-capped Starthroat (*Heliomaster constantii*)	1 (69 h)	*Cephalocereus maxonii* (Cactaceae)	45	Motagua Valley, Guatemala	Wendelken & Martin (1988)
Plain-capped Starthroat (*Heliomaster constantii*)	1 (50 h)	*Stenocereus eichlamii* (Cactaceae)	50	Motagua Valley, Guatemala	Wendelken & Martin (1988)
Copper-rumped Hummingbird (*Amazilia tobaci*)	Not given	Not given		Guarapo and Laguna Los Cocos, Venezuela	Poulin et al. (1994)
Buffy Hummingbird (*Leucippus fallax*)	Not given	Not given		Guarapo and Laguna Los Cocos, Venezuela	Poulin et al. (1994)
Several species, including *Leucippus* sp.	8 (1815 h)	*Stenocereus griseus* (Cactaceae)	45	Margarita Island, Venezuela	Silvius (1995)
White-bearded Hermit (*Phaetornis hispidus*)	Not given (470 h)	*Stenocereus griseus* (Cactaceae)	45	Lagunillas, Venezuela	Soriano et al. (1999)
White-bearded Hermit (*Phaetornis hispidus*)	Not given (380 h)	*Cereus repandus* (Cactaceae)	24	Lagunillas, Venezuela	Soriano et al. (1999)
Buffy Hummingbird (*Leucippus fallax*)	48 (180 h)	*Stenocereus griseus* (Cactaceae)	28	Cumaná, Venezuela	López Zerpa (2008)
Buffy Hummingbird (*Leucippus fallax*)	20 (180 h)	*Cereus repandus* (Cactaceae)	24	Cumaná, Venezuela	López Zerpa (2008)
Rufous-tailed Hummingbird (*Amazilia zacatl*)	6 (6 h)	*Pilosocereus leucocephalus* (Cactaceae)	50	Loma de Rogel, Mexico	Munguía-Rosas et al. (2009)
Ruby-throated Hummingbird (*Archilochus colubris*)	1	*Pyrus communis* (Rosaceae)	60	Johnson County, United States	Palis (2010)
Blue-chinned Sapphire (*Chlorestes notata*)	Not given (120 h)	*Muntingia calabura* (Muntingiaceae)	14	Porto Velho, Brazil	Ruschi et al. (2014)

lications. Complementarily, I made a search on Google Images using the same keywords to identify hummingbird frugivory in the wild.

In addition, I report three hummingbird frugivory events on blue passionflower (*Passiflora caerulea*) in Argentina. The blue passionflower is a vine native to southeastern Brazil, Paraguay, Bolivia, Uruguay, and Argentina (Deginani 2001). It produces orange berries, 15–44 mm in diameter, whose seeds (2.5–3.0 mm in diameter) are dispersed by birds (Deginani 2001, Palacio & Ordano 2018). Fieldwork was carried out at "Estancia San Isidro" (35°09'S, 57°23'W) located in the Biosphere Reserve "Parque Costero del Sur", Buenos Aires province, Argentina. The area is composed mostly of grasslands and forest patches locally called "talares" (Goya et

Table 1. Continuation.

Bird species	Number of observations (observation hours)	Plant species	Fruit diameter (mm)	Location	Source
Black-throated Mango (*Anthracothorax nigricollis*)	1 (32 h)	*Stenocereus griseus* (Cactaceae)	44	Cumaná, Venezuela	Marín-Espinoza & Durán-Maita (2016)
Copper-rumped Hummingbird (*Amazilia tobaci*)	1 (32 h)	*Stenocereus griseus* (Cactaceae)	44	Cumaná, Venezuela	Marín-Espinoza & Durán-Maita (2016)
Buffy Hummingbird (*Leucippus fallax*)	Not given (32 h)	*Stenocereus griseus* (Cactaceae)	44	Cumaná, Venezuela	Marín-Espinoza & Durán-Maita (2016)
Broad-billed Hummingbird (*Cynanthus latirostris*)	1	*Stenocereus griseus* (Cactaceae)	45	Jaumave Desert, Mexico	https://www.mindenpictures.com/search/preview/broad-billed-hummingbird-cynanthus-latirostris-hovering-feeding-on-pitaya/0_90097305.html
Anna's Hummingbird (*Calypte anna*)	1	*Diospyros* sp. (Ebenaceae)	15-90	Monterey, United States	https://abc11.com/weather/legend-says-persimmons-can-predict-winter-weather/1089733/
Green-backed Firecrown (*Sephanoides sephaniodes*)	1	*Diospyros* sp. (Ebenaceae)	15-90	Limache Valley, Chile	http://quintaescondida.com/annual-hummingbird-feast/
Gilded Hummingbird (*Hylocharis chrysura*)	2 (4 h)	*Passiflora caerulea* (Passifloraceae)	25-51	Magdalena, Argentina	This study
Glittering-bellied Emerald (*Chlorostilbon lucidus*)	1 (4 h)	*Passiflora caerulea* (Passifloraceae)	25-51	Magdalena, Argentina	This study

al. 1992). "Talares" are composed of four main native tree species (Goya et al. 1992): *Celtis ehrenbergiana* (Cannabaceae), *Scutia buxifolia* (Rhamnaceae), *Jodina rhombifolia* (Santalaceae), and *Schinus longifolia* (Anacardiaceae). In December 2014, I selected eight random plants to make focal observations on avian fruit consumption. Fruit-consumption events, including hummingbirds and passerines, were recorded at each plant for periods of 30 minutes (totaling 4 hours) within the first four hours after sunrise. I also measured fruit diameters of 53 fruits (11 plants) with a digital caliper to the nearest 0.1 mm.

RESULTS AND DISCUSSION

I found ten studies and three images reporting hummingbird frugivory (Table 1). Overall, I noted 23 fruit-hummingbird interactions comprising 15 bird species and 10 plant species, including personal observations (Table 1). On 5 December 2014, I recorded two Gilded Hummingbirds (*Hylocharis chrysura*) and one Glittering-bellied Emerald (*Chlorostilbon lucidus*) feeding on fruit of three Blue Passionflower plants (one individual per plant). Fruit consumption behavior was similar for both species. Hummingbirds first punctured closed fruits with their bill closed and then pushed them inside fruits. The three foraging bouts were performed while hovering. Although it was common to find pecked fruits by other birds exposing arils and seeds, the soft peel of the fruit exerted little resistance against hummingbird's beak. This behavior was similar to that found in Ruby-throated Hummingbird (*Archilochus colubris*) feeding on exotic *Pyrus communis* (Rosaceae) fruit (Palis 2010) and Blue-chinned Sapphire (*Chlorestes notata*) feeding on exotic *Muntingia calabura* (Muntingiaceae) fruit (Ruschi 2014). This behavior contrasts with most records of hummingbird frugivory, in which hummingbirds sip juice on exposed pulp of dehiscent fruit (Wendelken & Martin 1988, Silvius 1995, Munguía-Rosas et al. 2009). Regardless of the behavior shown, hummingbirds presumably use their tongue to drink the pulp juice, similar to nectar-feeding from flowers (Ruschi 2014).

Far from being rare events, observations at my study site accounted for a 23% of total bird-fruit interactions (three out of 13 total bird visits). The other bird species recorded were Rufous-bellied Thrush (*Turdus rufiventris*; five visits), Screaming Cowbird (*Molothrus rufoaxillaris*; four visits), and Sayaca Tanager (*Thraupis sayaca*; one visit). Nevertheless, the low sample size and number of visits suggest that these results should be regarded with caution. Few studies have reported hummingbird frugivory taking into account other frugivore species from the assemblage. Wendelken & Martin (1988) found substantial levels of hummingbird frugivory in *Stenocereus eichlamii* and *Cephalocereus maxonii* (Cactaceae) in Guatemala, with 11.8% and 8.16% out of 98 and 34 total bird visits, respectively. By contrast, Silvius (1995) found low levels of hummingbird frugivory in two *S. griseus* populations (1.1% and 6.1% out of 134 and 138 total bird visits, respectively) in Venezuela. It is worth noting that the dominant frugivore of populations of *S. griseus* and *Cereus repandus* (Cactaceae) in Venezuela was the Buffy Hummingbird

(*Leucippus fallax*), with records on all sampling days (18 days, 180 observation hours; López Zerpa 2008). This suggests that fruit consumption by hummingbirds may be more common than previously thought, at least in certain plant families, such as cacti.

My review shows that hummingbird frugivory extends across a broad geographic range throughout the Americas and mostly involves interactions with Cactaceae, suggesting that it may be a widespread phenomenon. The fact that most records are on Cactaceae may be due to: (1) the dehiscent nature of these fruit exposing their sugary pulp, and (2) the important food resource they provide in arid environments. Although none of these interactions have been reported to lead to seed consumption and/or dispersal, there is evidence that hummingbirds include seeds in their diet. For instance, Poulin et al. (1994) found 24 seeds of *Erythroxylum havanense* (Erythroxylaceae) in one stomach sample of Copper-rumped Hummingbird (*Amazilia tobaci*) from Venezuela. These authors also found seeds belonging to three different plant taxa (*Croton conduplicatus*, Euphorbiaceae, *Lycium nodosum*, Solanaceae, and one unidentified species) in 121 stomach samples taken from Buffy Hummingbirds. The idea that hummingbirds could act as seed dispersers requires further studies in the light of seed-viability experiments, and, if hummingbird seed dispersal is confirmed, it would represent an interesting overlooked mutualism.

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