

Collared Forest-Falcon (*Micrastur semitorquatus*) preying on a squirrel in a fragment of Atlantic Forest with a revision of the predation events for the species

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ABSTRACT: We recorded predation on the squirrel *Guerlinguetus ingrami* by a Collared Forest-Falcon (*Micrastur semitorquatus*) through camera trapping in a forest fragment of Atlantic Forest in the interior of São Paulo state, Brazil. The squirrel was captured while it moved across the forest floor. A compilation from bibliographic and other sources resulted in 68 vertebrate and 03 invertebrate species as prey of the Collared Forest-Falcon, with birds more commonly reported in the diet of the species. The majority of prey (66% of species) did not exceed 300 g, but some prey species (12%) such as guans (*Penelope* spp.) were heavier than the falcon. The Collared Forest-Falcon could affect the population dynamics of smaller vertebrates in forest fragments of Atlantic Forest due to its flexibility in diet and habitat use, an aspect that deserve a more thorough investigation.

KEY-WORDS: bird-mammal, hawk diet, interaction, predator-prey, Seasonal Semideciduous Forest.

The Collared Forest-Falcon (*Micrastur semitorquatus*) is the largest member of the genus composed of seven species of forest falcons, with a total size varying from 46 to 58 cm with average body mass of 563 g for males and 800 g for females (Thorstrom 2000, Ferguson-Lees & Christie 2001, Menq 2016).

The species is found from southern Mexico to central Argentina, including Brazil (Ferguson-Lees & Christie 2001, Thorstrom 2007, Sigrist 2014). Its known habitat includes primary forest, forest edge and secondary forest with dense undergrowth (del Hoyo *et al.* 1993). Individuals nest in cavities of trees and rocks; though there are also records of nests in human buildings (Carrara *et al.* 2007, Vallejos *et al.* 2008, Viana *et al.* 2012). In Guatemala, the home range of Collared Forest-Falcon varied from 996 ha during the reproductive season to 555 ha during the non-reproductive season (Thorstrom 2007).

The Collared Forest-Falcon is a predator that captures its prey on the ground and in vegetation, through ambushes from hidden perches (Sigrist 2014, Menq 2016). It also follows army ant columns, where it

captures insectivorous birds (Ferguson-Lees & Christie 2001, Antas 2005). Here we report the predation of the squirrel *Guerlinguetus ingrami*, a predominantly arboreal rodent some 19.6 cm in length and 242 g in body mass (Bonvicino *et al.* 2008), which also forages on the ground, by *M. semitorquatus* (Collared Forest-Falcon), and include a summary of the predation events known for this falcon.

Our study area was a forest fragment of 79 ha in the Abraão de Moraes Astronomical Observatory, with a predominance of Atlantic Forest Biome, Semideciduous Seasonal Forest phytophysiology, in Valinhos city, São Paulo state, southeastern Brazil. This is one of the few forest remnants remaining in the region.

The predation event was recorded through a camera trap (MiniTrapa model - with infrared sensor) installed 30 cm from the ground as part of a survey of medium and large mammals. In addition, we collated the available data on predation events by *M. semitorquatus* from the bibliography and public databases such as Google Images, Wikiaves, YouTube and Flickr using as keyword search “*Micrastur semitorquatus*”.

At 09:00 h on 9 October 2016 we recorded a single squirrel *G. ingrami* foraging on the ground on the leaf litter under a closed canopy of an old (45 years) secondary forest (Fig. 1A). The following day, at about the same time and location (23°0'17.48''S; 46°57'48.22''W), we recorded a *M. semitorquatus* attacking a *G. ingrami* on the ground (Fig. 1B). Seconds later, the falcon carried away its prey, probably towards a perch to feed on it. The photographed bird had barred chest plumage, a dark throat and collar and a long and voluminous tail (Fig. 1B), field marks that characterize it as a juvenile of *M. semitorquatus* (Ferguson-Lees & Christie 2001, Menq 2016).

The revision of predation events of *M. semitorquatus* resulted in the identification of 71 preyed species

(Appendix I) with birds being the most common prey (50 species), followed by mammals ($n = 11$), reptiles ($n = 6$), invertebrates ($n = 3$) and amphibians ($n = 1$). Although most prey species (66%) had a mean body mass less than 300 g (Fig. 2). Prey of *M. semitorquatus* cover a wide size spectrum, with 12% of prey exceeding the mass of the predator itself (Fig. 2).

This note presents the first documented predation record of a *G. ingrami* squirrel by *M. semitorquatus*. Other species of squirrels (*Sciurus deppei* and *S. yuacatanensis*) have been reported as prey of this raptor (Throstrom 2000). *Guerlinguetus* squirrels are arboreal and inhabit the intermediate and lower strata of the forest descending to the ground to forage (Bonvicino *et al.* 2008), where they are potentially more vulnerable to predators. In the

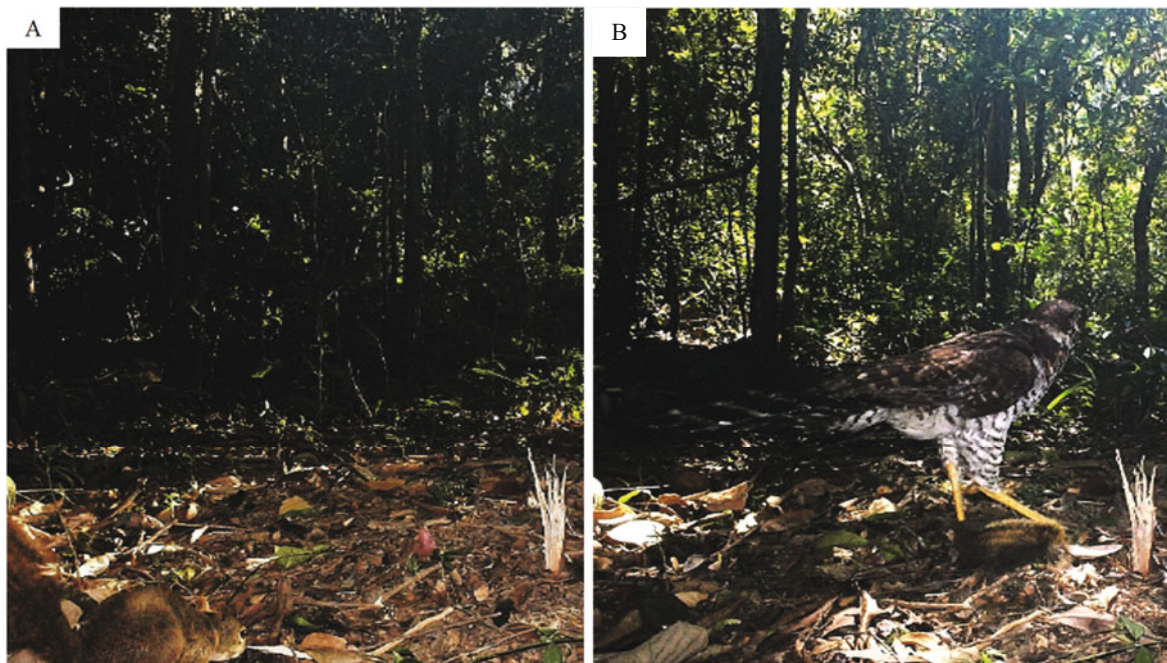


Figure 1. (A) *Guerlinguetus ingrami* foraging on the ground; (B) Predation of *G. ingrami* by a juvenile *Micrastur semitorquatus*.

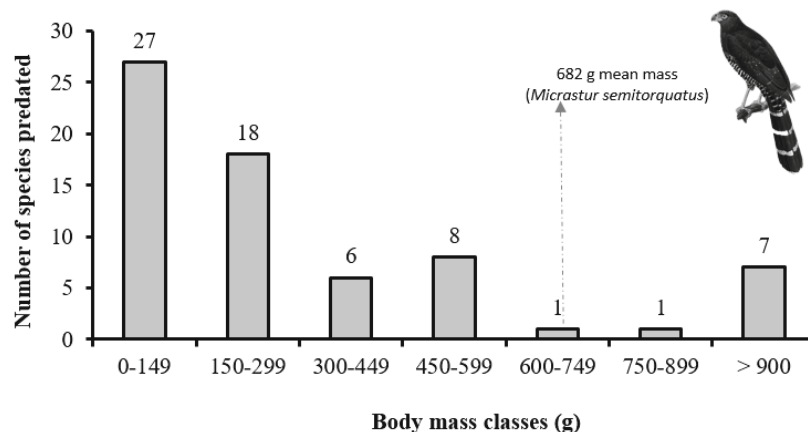


Figure 2. Prey eaten by *Micrastur semitorquatus* distributed in 150 g body mass classes. Data from Appendix I.

studied forest fragment, we recorded other potential prey of Collared Forest-Falcon, including Plumbeous Pigeon (*Patagioenas plumbea*), Rusty-margined Guan (*Penelope superciliosus*), Calico Lizard (*Tropidurus torquatus*), Black-and-white Tegu (*Salvator marianae*), and Brazilian Forest Rabbit (*Sylvilagus brasiliensis*).

The predation event described here demonstrates the agility and behavioral flexibility of *M. semitorquatus* as a predator that inhabits the forest interior. Other studies suggest that this falcon has the most diversified diet within the *Micrastur* genus (Thorstrom 2000, Appendix I). Our compilation indicates that birds are also a relevant dietary component, in terms of both diversity and biomass, in the diet of Collared Forest-Falcon.

The occurrence of *M. semitorquatus* in a forest remnant surrounded by a highly human-modified landscape highlights the capacity of the species to adapt to disturbed environments (Viana *et al.* 2012). In addition, the study site is located in a region with abundant granite outcrops whose crevices and cavities provides suitable nesting sites for *M. semitorquatus* individuals, as shown in other regions of Brazil (Vallejos *et al.* 2008).

The demonstrated flexibility in diet and habitat use (del Hoyo *et al.* 1993, Thorstrom 2000) suggests that *M. semitorquatus* could be a local avian top predator (Brook *et al.* 2012, Colman *et al.* 2014) affecting the population dynamics of small vertebrates in forest fragments in the Atlantic Forest. The role of *M. semitorquatus* (and other forest falcons) in the trophic webs of forest fragments should be accessed through quantitative ecological studies, similar to those conducted in Guatemala (Thorstrom 2000).

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APPENDIX I

List of prey species of *Micrastur semitorquatus* compiled from different sources.

Prey species	Adult body length (cm)	Adult body mass (g)	Study regions	Sources
Arthropods				
Unidentified species (ant)	-	<5	Costa Rica	Skutch (1981), Mays (1985)
Unidentified species (cicada)	-	10	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
Unidentified species (spider)	-	10	Costa Rica	Skutch (1981)
Amphibian				
Unidentified species (frog)	-	20	Guatemala	Thorstrom (2000)
Birds				
<i>Amazona amazonica</i>	32 ¹	384 ⁷	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Anodorhynchus hyacinthinus</i> [#]	70–100 ¹	1500 ⁷	Brazil, Mato Grosso	Salles (2010)
<i>Aramides cajaneus</i>	42 ¹	403 ⁷	Brazil, Pantanal	Guedes (1993), Carrara <i>et al.</i> (2007)
<i>Aulacorhynchus</i> spp.	33*	150 ³	Guatemala	Thorstrom (2000)
<i>Brotogeris chiriri</i>	23 ¹	50*	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Cacicus cela</i>	26 ¹	80 ⁷	Brasil, Pantanal, Peru ^a	Robinson (1994) ^a , Carrara <i>et al.</i> (2007) ^b

Prey species	Adult body length (cm)	Adult body mass (g)	Study regions	Sources
Caprimulgidae	20*	70*	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Celeus</i> spp.	25*	85 ³	Guatemala	Thorstrom (2000)
<i>Columbina picui</i>	17 ¹	53 ⁷	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Crax rubra</i>	-	500 ³	Guatemala	Thorstrom (2000)
<i>Crotophaga ani</i>	36 ¹	148 ⁷	Brazil, Pantanal	Guedes (1993), Carrara <i>et al.</i> (2007)
<i>Crotophaga major</i>	46 ¹	150 ⁷	Brazil, Pantanal	Guedes (1993)
<i>Crotophaga sulcirostris</i>	34*	80*	Mexico	Willis <i>et al.</i> (1983)
<i>Crypturellus obsoletus</i>	25–30 ¹	360–600 ¹	Brazil, São Paulo	Souza (2015)
<i>Cyanocorax chrysops</i>	34 ¹	200*	Brazil, Mato Grosso	Salles (2012)
<i>Cyanocorax morio</i>	35*	200 ³	Guatemala	Thorstrom (2000)
<i>Dendrocincla homochroa</i>	-	42 ⁴	Guatemala	Thorstrom (2000)
<i>Eurypyga helias</i>	45 ¹	220 ⁴	Brazil, Mato Grosso	Labelle (2010)
<i>Gallus gallus domesticus</i>	50*	>3000	El Salvador	Slud (1964), West (1988)
<i>Guira guira</i>	38 ¹	141 ⁷	Brazil, Pantanal	Guedes (1993), Carrara <i>et al.</i> (2007)
<i>Geotrygon albifaces</i>	24*	55*	Guatemala	Vannini (1989)
<i>Geotrygon montana</i>	24 ¹	55*	Guatemala	Vannini (1989)
<i>Heliornis fulica</i>	28 ¹	150 ⁷	Brazil, São Paulo	Souza (2014)
<i>Icterus gularis</i>	20*	65*	Mexico	Sutton <i>et al.</i> (1942)
<i>Laterallus viridis</i>	18 ¹	140*	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Leptotila</i> spp.	27*	160 ³	Guatemala	Thorstrom (2000)
<i>Melanerpes</i> spp.	18*	81 ³	Guatemala	Thorstrom (2000)
<i>Meleagris ocellata</i>	100 ¹	3000 ³	Guatemala	Thorstrom (2000)
<i>Mesembrinibis cayennensis</i>	58 ¹	750 ⁷	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Momotus</i> spp.	44*	133 ³	Guatemala	Thorstrom (2000)
<i>Odontophorus capueira</i>	24 ¹	426.5 ⁶	Brazil, Paraná	Vallejos <i>et al.</i> (2008)
<i>Ortallis canicollis</i>	50–56 ¹	480–600 ¹	Brazil, Pantanal	del Hoyo (1997), Olmos <i>et al.</i> (2006), Carrara <i>et al.</i> (2007)
<i>Ortallis</i> spp.	50*	450*	Mexico, Panamá ^b	Sutton <i>et al.</i> (1942), Wetmore (1965) ^b
<i>Ortalis vetula</i>	50*	450 ³	Guatemala	Thorstrom (2000)
<i>Patagioenas plumbea</i>	34 ⁷	215 ⁷	Brazil, São Paulo	This study
<i>Penelope jacquacu</i>	71 ¹	1530 ¹	Peru	Robinson (1994)
<i>Penelope obscura</i>	68–75 ¹	1000–1200 ¹	Brazil, Paraná ^a ; Argentina ^b	Vallejos <i>et al.</i> (2008) ^a , Cuñado (2014) ^b
<i>Penelope purpurascens</i>	50*	600 ³	Guatemala	Thorstrom (2000)
<i>Penelope</i> sp.	68 ¹	1000 ¹	Brazil, Rio de Janeiro	Blanco (2013)
<i>Piaya cayana</i>	44 ¹	75*	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Primolius auricollis</i>	40 ¹	250 ⁷	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Psarocolius angustifrons</i>	41 ¹	258*	Peru	Robinson (1994)

Prey species	Adult body length (cm)	Adult body mass (g)	Study regions	Sources
<i>Psarocolius decumanus</i>	42 ¹	258 ⁷	Brazil, Pantanal	Carrara <i>et al.</i> (2007)
<i>Pteroglossus torquatus</i>	-	220 ³	Guatemala	Thorstrom (2000)
<i>Quiscalus mexicanus</i>	42 ⁹	160 ⁹	Mexico	Flores (2017)
<i>Ramphastos</i> sp.	42–61 ¹	350*	Brazil, Paraná	Vallejos <i>et al.</i> (2008)
<i>Ramphastos sulfuratus</i>	50*	350 ³	Guatemala	Thorstrom (2000)
<i>Rupicola rupicola</i>	27–32 ¹	200 ⁴	North Amazonia ^a ; Guiana ^b	Trail (1987) ^b , Sigrist (2014) ^a
<i>Strix virgata</i>	34 ¹	240 ³	Guatemala	Thorstrom <i>et al.</i> (1990)
<i>Taraba major</i>	19 ¹	50*	Brazil, Pantanal	Guedes (1993)
Mammals				
<i>Artibeus</i> spp.	90*	50 ³	Guatemala	Thorstrom (2000)
<i>Callithrix humeralifer</i>	21.5 ²	470 ²	Brazil, Mato Grosso	Rylands (1981)
<i>Callithrix jacchus</i>	21.5 ²	470 ²	Brazil, Paraíba ^a	Alonso & Langguth (1989) ^a , Pontes & Soares (2005) ^b
<i>Callithrix penicillata</i>	21.5 ²	470 ²	Brazil, São Paulo	This study
<i>Guerlinguettus ingrami</i>	19.6 ⁴	242 ⁵	Brazil, São Paulo	This study
<i>Heteromys</i> spp.	-	76 ³	Guatemala	Thorstrom (2000)
<i>Sciurus deppei</i>	-	205 ³	Guatemala	Thorstrom (2000)
<i>Sciurus yucatanensis</i>	-	400 ³	Guatemala	Thorstrom (2000)
<i>Sigmodon hispidus</i>	-	150 ³	Guatemala	Thorstrom (2000)
Unidentified rodent # ²	-	-	Brazil, Paraná	Vallejos <i>et al.</i> (2008)
Unidentified marsupial# ²	-	-	Brazil, Paraná	Vallejos <i>et al.</i> (2008)
Reptiles				
<i>Ameiva</i> sp.	15*	40*	Brazil, Pantanal	Guedes (1993)
<i>Corytophanes</i> spp.	-	<150*	Guatemala	Thorstrom (2000)
<i>Coluber</i> sp.	-	45 ³	Guatemala	Thorstrom (2000)
<i>Ctenosaura similis</i>	130 ⁸	1500 ⁸	Vera Cruz, México	Haemig (2012)
<i>Salvator marianae</i>	100*	>1000*	Brazil, São Paulo	Martinhão (2012)
<i>Micrurus</i> sp. (coral snake)	-	<150*	Brazil, Mato Grosso do Sul	Messias (2015)

¹Sigrist (2014), ²Reis *et al.* (2015), ³Thorstrom (2000), ⁴Hilty 2002, ⁵Ribeiro *et al.* (2010), ⁶del Hoyo *et al.* (1993), ⁷Wikiaves, ⁸Savage (2002), ⁹Wehtje (2003).

“^a” and “^b” refers to the authors responsible for information.

*Based on species of the same genus.

data not used in the graphic;

#¹ the predation reported was of macaw nestlings (undefined mass);

#² undefined species (may be great variation on the mass).