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NESTLING'S PELLETS OF THE GREAT KISKADEE (*PITANGUS SULPHURATUS*) IN BRAZILIAN URBAN ENVIRONMENT

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Resumen. – Pelotas de pichones del Ben-te-veo (*Pitangus sulphuratus*) en ambiente urbano brasileño. – El Ben-te-veo es una especie común en las áreas urbanas de Brasil, pero no se ha estudiado mucho. Este estudio tuvo como objetivo vigilar su dieta mediante el análisis de pelotas en su ambiente. Los nidos fueron examinados y controlados en un ambiente urbano en Brasil, entre julio de 2007 y octubre de 2008. Se analizaron 218 pelotas y no tuvo preferencia por un tipo de alimento. Geco casero tropical (*Hemidactylus mabouia*) fue el único vertebrado que ofreció a los pichones, registrados por el método. En las pelotas se registró varios elementos de origen humano, lo que demuestra la capacidad del Ben-te-veo de utilizar este recurso único y su capacidad oportunista de adaptarse en el entorno urbano.

Abstract. – The Great Kiskadee (*Pitangus sulphuratus*) is a common species in Brazilian urban areas, but it is not well studied. This study aimed to monitor its diet through pellet analysis. Nests were screened and monitored in a Brazilian urban environment from July 2007 to October 2008. We analyzed 218 pellets and found no preference for one type of food item. The African House Gecko (*Hemidactylus mabouia*) was the only vertebrate offered to nestlings. The pellets were composed of several items of human origin, which demonstrates the ability of the Great Kiskadee to make use of these items. This study shows the wide food niche of this species beginning with the nestling stage, and its ability to adjust successfully to the urban environment due to its opportunistic feeding behavior. *Accepted 26 June 2012.*

Key words: Great Kiskadee, *Pitangus sulphuratus*, Tyrannidae, food niche, nestling diet, opportunism, pellets, urbanization.

INTRODUCTION

Pellet-casting is well known in raptors and owls (Reed & Reed 1928, Below 1979, Lyman 2012). These carnivorous birds consume the flesh together with bones, hair, fur, feathers, and other indigestible parts of their prey (Wang *et al.* 2009, Lyman 2012). In some species, when a prey is captured, it is swallowed whole and channeled directly to the gizzard where the digestive fluids act on the soft tissues. The hard, undigested materials, often more or less intact, are compacted into a pellet that travels from the gizzard into a space above known as the proventriculus, where it is stored for a few hours and ejected before another food intake (Reed & Reed 1928, Wang *et al.* 2009).

The pellets have been reported in 18 orders and 67 families comprising 316 species, most (41%) including species of Falconiformes and Strigiformes (Below 1979). Raptors and owls, which regularly eat other animals, are well known for casting pellets (Sutherland 2005, Lyman 2012). Fish-eating species, such as kingfishers, herons, and

crakes similarly cast pellets, although grebes' pellets don't have a defined shape. They are composed mostly of the fish bones, aquatic insects, mollusks, crustaceans, and small amphibians, totally dissolved by the strong acid in the bird stomach (Wang *et al.* 2009).

Little is known about the presence of this characteristic in other groups of birds, such as the Passeriformes, although there are a lot of works that include gulls, cormorants, and seabirds (Marquiss & Leitch 2008, Petracci *et al.* 2009, Steenweg *et al.* 2011). This study is based on the record of casting pellets from nestlings of a passerine in Brazil, the Great Kiskadee (so far only one record by Argel-de-Oliveira *et al.* 1998). Since this feature is unusual for a fairly small songbird, the goal is to describe how this behavior occurs, the number, shape, and composition of pellets and other important features.

The Great Kiskadee is a conspicuous bird that occurs in open habitats, such as parks, towns, plantations, and pastures (Sick 1997). The nest is large and globular, and the parents feeds their nestlings with several items, such as eggs of other birds, amphibians, fish, insects, snails, fruits, and seeds (Latino & Beltze 1999, Sigrist 2006). This species occurs and can benefit in an urban environment (Amâncio *et al.* 2008, Echeverría & Vassallo 2008, Marini & Garcia 2005). Since this species is omnivorous, the study of its diet, including at nestling stage, can contribute to understand its ecological relationships in the urban environment, and how the particular features of this environment are explored (Greenberg *et al.* 1997, Morneau *et al.* 1999, Morris 2005).

METHODS

Study area. The study was carried out on the Umuarama Campus of the Federal University of Uberlândia (18°55'23"S, 48°15'19"W), municipality of Uberlândia, Minas Gerais, Brazil, from July 2007 to October 2008. The region is mostly characterized by Cerrado and has two distinct seasons, dry and rainy. The hottest months are February, October, and November (monthly mean = 23.5°C) and the wettest are December and January (monthly average over 300 mm). The campus area covers approximately 4.17 ha at an altitude of 865 m a.s.l. (Rosa *et al.* 1991), with the presence of buildings, parking, streets, open areas, gardens, and native and exotic trees, which offer food and shelter to the local avifauna (Franchin *et al.* 2004, Faleiro & Amancio-Pereira 2007).

Nest and pellet search. Nests were found on all substrates potentially appropriate for nesting on the campus, including trees and other natural substrates, roofs, and poles. We monitored the activity at each nest as well as the nestlings' ages, when the regurgitation of pellets started. The pellets were obtained during the breeding season of the Great Kiskadee, on the ground just below the nest, because nestlings cast them in the nest entrance.

Pellet analysis. We recorded pellets number by nest, volume (determined by multiplying the measurements of length, height, and width, with a 0.1 mm precision), biomass (the pellets were dried at 50°C for 48 h and weighed), and the composition and proportions of items in each pellet (%).

After weighing the pellets, they were stored in plastic containers and fixed in 70% alcohol for subsequent analysis. The proportion of prey identification followed the method suggested by Green (1989) for studies of bird feces. Since the pellets of Great Kiskadee nestlings are small, this method was adapted to obtain a secure proportion of items (Sutherland 2005). Each pellet was analyzed on a Petri dish of 5.2 cm diameter, beneath which was placed a circle with the same diameter, subdivided into 10 equal parts

(sectors). Each sector was limited in its periphery by a band of parallel 0.8 cm width. The items were separated by bands, according to its type, and their frequencies were obtained by making estimates and percentage of conversions to deal with the occupation of the bands and pellet sample. Finally, the prey items were identified according to Santos (1982), Lorenzi *et al.* (2003), Costa *et al.* (2006), and Bonner & Nisley (2008).

Statistical analysis. For data analysis, we used BioEstat 3.0 Program (Ayres *et al.* 2000), considering the significance level of 0.05. The Student test was used to determine differences in dry biomass pellets at seasons and also, the pellet volume between seasons. All data were log-transformed to normalize them. ANOVA was used to compare the pellets' volume at seasons and biomass between seasons.

RESULTS

We found six nests of the Great Kiskadee (three during the dry season and three during the rainy season), each nest with two nestlings. The maximum radius of ejected pellets was about nine meters to the nest. We collected 218 pellets, 107 (49%) in the dry season, which average 35.7 pellets per nest and 111 (51%) in the rainy season, which a mean of 64.3 pellets per nest. The nestlings began to cast pellets 7.7 ± 1.9 days of age on average.

The mean volume of pellets was 1.4 ± 0.1 cm^3 (n = 152). The pellets had a length of 1.5 ± 0.5 cm, height of 0.8 ± 0.3 cm and width of 1 ± 0.5 cm. We found no difference between seasons (F = 1.29, df = 1, P = 0.26) in volume of pellets, neither when we compared within seasons (dry: t = 0.60, df = 65, P = 0.55; rainy: t = -1.02, df = 83, P = 0.31). In 30.3% (n = 66) of the pellets it was impossible to determine the volume with certainty because they were destroyed by people trampling. The shape of the pellets are similar to those of the Tropical Screech-Owl (*Megascops choliba*) (ZPP pers. observ.), with a predominant elliptical shape (n = 128; 84.2%) (Fig. 1).

The dry weight of pellets during the dry season was 0.3 ± 0.3 g and 0.4 ± 0.3 g in the rainy one, both significantly different in the seasons (dry: t = 19.75, df = 106, P = 0.00; rainy: t = 13.80, df = 110, P = 0.00) and among seasons (F = 13.74, df = 1, P = 0.00).

We analyzed 424 items of which 194 were present in the pellets of the dry season and 230 of the rainy season. In 35 items (8.3%), it was impossible to identify the group (Table 1). We found no preference for the type of food item between seasons (dry: t = 1.54, df = 3, P = 0.09; rainy: t = 1.97, df = 3, P = 0.07).

The fruits that consumed more frequently were *Ficus benjamina* (n = 92; 22.1%), *Ficus elastica* (n = 27; 11.7%), and *Morus nigra* (n = 30, 7.4%) (Table 1). The most abundant groups of insects in the diet of nestlings were: Coleoptera (n = 23; 10%), Formicidae (n = 19, 8.3%), and Hymenoptera (n = 13, 5.7%) (Table 1). The African House Gecko (*Hemidactylus mabouia*) was the only vertebrate species in the pellets, and it was found with similar frequencies in different seasons (dry: n = 11, 5.7%; rainy: n = 13, 5.7%). Gastropoda were recorded during both seasons (dry: n = 6, 3.1%; rainy: n = 3, 1.3%). Unusual items also recorded included human hair (n = 10, 2.1%), stones (n = 10, 3.3%), and dog food (n = 7, 1.8%) (Table 1).

DISCUSSION

Most of the pellets of Great Kiskadee nestlings were found near the nest as recorded for owls, too (Towery 2011). However, the distant radius of ejected pellets compared to the pellets just below the nest, can be explained by the behavior of parents to clean the nest removing egg shells, feces, and pellets (Podulka *et al.* 2004).

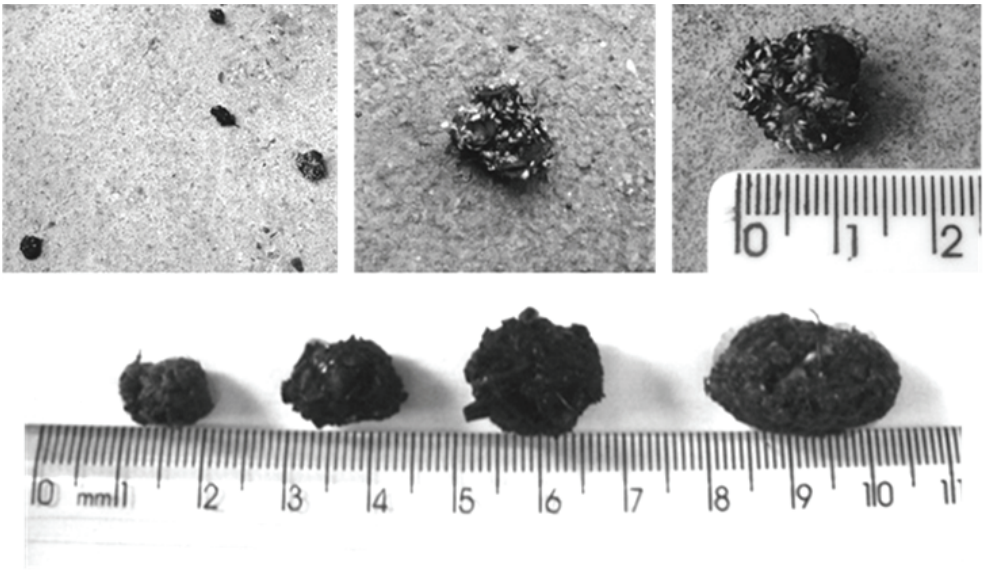

FIG. 1: Great Kiskadee nestling's pellets from one nest on wet season of 2007(above) and from another nest in dry season of 2008 (below), on the Umuarama Campus of Federal University of Uberlândia, Brazil (photographed by ZPP).

The volume and shape of pellets of Great Kiskadee nestlings are unique and quite variable. Omnivorous, insectivorous, herbivorous, and granivorous birds have a proventriculus, responsible for the gastric digestion, and a gizzard separated by isthmus (Whittow 2000, Evans & Heiser 2004). There is evidence that omnivorous birds have a gizzard with two pairs of opposing muscles termed thick and thin pairs, which are composed of circular muscles, in the same way of some species like herons, hawks, and owls (Whittow 2000). Probably, these features of the digestive tract are the main factor responsible for the standard size and form of pellets, similar to the owls, whose pellet is formed 6–12 h after food ingestion (Reed & Reed 1928, Wang *et al.* 2009, Towery 2011). Shorebird pellets are often elongated while they are rounded and teardrop-shaped in gulls (Below 1979). However, pellet production is hard to expect among passerines, especially nestlings. Even for species with adults regurgitating pellets, such as the Common Kingfisher (*Alcedo atthis*), their fledglings do not so but eat and digest the whole prey (Evans & Heiser 2004). In Great Horned Owl nestlings, the first pellet is produced in the 28 day of age (Errington 1930).

Pellets, in general, are usually ovoid, but they can vary in size and shape according to species and dependent of what type of food is eating (Below 1979). Although we found no preference for the type of food item, the weight of the pellets was higher in the rainy season, when the availability of resources tends to increase and parents have the opportunity to offer more food to the nestlings (Pereira 2011). The Great Kiskadee is a common bird in South America (Ridgely & Tudor 1994) and frequently registered in urban environments (Amâncio *et al.* 2008). It feeds on a large variety of food items since fruits, insects, small vertebrates (Latino & Beltze 1999), and

TABLE 1: Items, number (N), frequency (%), and volume* (%) of *Pitangus sulphuratus* nestling's diet through pellet analysis according to the season (Umuarama Campus of Federal University of Uberlândia, Brazil). * Adapted from Green (1989).

Food	Dry season			Rainy season			General		
	N	F (%)	V* (%)	N	F (%)	V* (%)	N	F (%)	V* (%)
Invertebrates									
Insecta									
Blattodea	1	0.52	100.00	2	0.87	76.65	3	0.70	88.32
Cicadidae	3	1.55	94.03	5	2.17	88.34	8	1.86	91.18
Coleoptera	9	4.64	45.07	23	10.00	54.96	19	7.32	50.01
Scarabaeidae	-	-	-	8	3.48	62.20	8	3.48	62.20
Diplopoda	2	1.03	64.3	-	-	-	2	1.03	64.30
Diptera (larvae)	-	-	-	1	0.43	10.00	1	0.43	10.00
Formicidae	2	1.03	4	19	8.26	30.51	21	4.64	17.25
Hemiptera	-	-	-	4	1.74	62.77	4	1.74	62.77
Hymenoptera	5	2.58	26.38	13	5.65	46.74	18	4.11	36.56
Lepidoptera	3	1.55	56.66	2	0.87	2.70	5	1.21	29.68
Odonata	-	-	-	2	0.87	42.90	2	0.87	42.90
Orthoptera	1	0.52	37.47	-	-	-	1	0.52	37.47
Arachnida									
Araneae	-	-	-	1	0.43	6.70	1	0.43	6.70
Mollusca									
Gastropoda	6	3.09	25.73	3	1.30	13.03	9	2.19	19.38
Vertebrates									
Reptilia									
Hemidactylus mabouia	11	5.67	83	13	5.65	44.90	24	5.66	63.95
Fruits									
Ficus elastica	-	-	-	27	11.74	59.35	27	11.74	59.35
Ficus sp.	53	27.32	74.68	39	16.96	61.56	92	22.14	68.12
Ligustrum lucidum	13	6.70	17.92	1	0.43	11.10	14	3.56	14.51
Morus nigra	21	10.82	72.92	9	3.91	29.94	30	7.36	51.43
Murraya paniculata	2	1.03	7.55	-	-	-	2	1.03	7.55
Phoradendron affine	3	1.55	41.67	2	0.87	50.00	5	1.21	45.83
Syzygium jambolanum	9	4.64	70.56	6	2.61	98.58	15	3.62	84.57
Others									
Brachiaria sp.	1	0.52	5.00	1	0.43	25.00	2	0.47	15.00
Human hair	1	-	-	9	-	9.52	10	-	-
Egg shell	2	1.03	10.00	-	-	-	2	1.03	10.00
Nylon	1	-	-	-	-	-	1	-	-
Leaves	-	-	-	4	1.74	7.66	4	1.74	7.66
Rice (*Oryza* sp.)	3	1.55	37.48	-	-	-	3	1.55	37.48
Rocks	4	2.06	17.50	6	2.61	10.63	10	2.33	14.06
Dog food	5	2.58	82.00	2	0.87	12.50	7	1.72	47.25
Remains of items	13	6.70	30.80	9	3.91	34.42	22	5.30	32.61
Soil sediment	-	-	-	4	1.74	9.78	4	1.74	9.78
Unidentified	20	10.31	61.50	15	6.52	44.57	35	8.41	53.03
Total	**194**	**-**	**-**	**230**	**-**	**-**	**424**	**-**	**-**

even rice and dog food as registered in the present study. However, insects were the most abundant prey, and they provided important food resources due to high rates of proteins and lipids (Conconi & Rodriguez 1977, Costa-Neto 2003), essential for the growth and development of nestlings (Gill 1995). Coleoptera, the most representative group in the pellets, are very abundant in the rainy season (Pinheiro *et al.* 2002) and have hard structures that are well preserved in pellets. Formicidae and Hymenoptera are social insects that live in large groups, thus they are easily captured and provide a prime food resource for opportunistic predators (Olson & Alvarenga 2006), such as the Great Kiskadee. However, in our study we recorded a number of unusual items, e.g., human hair, nylon, rocks, and dog food – the last item also found in egret pellets (Marquiss & Leitch 2008). For gulls, other unusual items were recorded, such as parts of glass, plastic, and metal (Below 1979). The Common Kingfisher feeds not exclusively on fish, but also on other small animals, such as insects, molluscs, crustaceans, and amphibians. Regularly, their pellets are aggregated with the exoskeletons of insects (Evans & Heiser 2004), suggesting the importance of this element to compact the pellet. Pellets of other non-passerines like cuckoos (Gill 1980), vultures (Newton 1982), and herons (Wang *et al.* 2009) also contain the same element that compacts the pellet.

So far, the presence of pellets was well recorded only for a single family of birds of the Passeriformes, the Laniidae. These birds are small but avid predators of insects, birds, and small mammals (Yosef & Pinshow 2005, Wang *et al.* 2009), with pellet records for the Great Grey Shrike (*Lanius excubitor*) (Wang *et al.* 2009, Antczak 2010), Tiger Shrike (*Lanius tigrinus*) (Wang *et al.* 2009), and Loggerhead Shrike (*Lanius ludovicianus*) (Álvarez-Castañeda 2002). With our study, we have details on records of pellets for the Great Kiskadee nestlings, and we encourage more studies to clarify this activity in passerines and other groups.

Low dietary requirements and the ability to profit from urban resources are prerequisites for the Great Kiskadee to adjust to urbanizations (Argel-de-Oliveira *et al.* 1998), and may explain its increasing population size in these environments (Marini & Garcia 2005). The opportunism of this species is reflected by the use of human-derived food sources for nestlings as examined in this study.

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