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ARTICLE

Detailed description and seasonal variation in the diet of the Silvery-Cheeked Antshrike *Sakesphorus cristatus* (Wied, 1831) (Aves: Thamnophilidae) in a Brazilian semi-arid forest

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ABSTRACT: Despite being an important area for endemic species of birds, the *Caatinga* biome is highly fragmented due to anthropogenic influences and there is a lack of study on many aspects of its birds' biology. In this semiarid environment, rainfall is highly seasonal, with two different and well-defined periods: a long dry season, and a short rainy season. This study aimed to qualify and quantify the diet of *Sakesphorus cristatus*, an endemic thamnophilid bird of the *Caatinga*, as well as to determine whether there was temporal variation between two different seasons and between dry seasons of two consecutive years. Surprisingly, this was the first study to have focused on describing and quantifying items found of any bird species' diet in the *Caatinga*. We analyzed the stomach contents of 72 specimens collected in the municipality of São Felix do Coribe, Bahia, Brazil. Data analysis included relative abundance and occurrence, average consumption/sample and alimentary importance index of each food category. Sampling adequacy was assessed using cumulative curves constructed with diversity index and coefficient of variation. In general there is a high predominance of ants and termites, with seasonal shifts in the proportion of each item, and a high contribution of caterpillars during the breeding season. During the dry season, the most predominant prey categories in the diet were Formicidae, Isoptera and Coleoptera (adult, A), while during the rainy season, there was an increase in the proportion of Isoptera, Coleoptera (A) and Lepidoptera (larvae) consumption and a decrease in Formicidae. There was no significant difference between consumption of prey items between the two dry seasons. The overall analysis suggests that *S. cristatus* feeds mainly on the aforementioned insects and is an opportunistic species, adjusting its diet according to their prey availability.

KEY-WORDS: *Caatinga*, feeding biology, insectivory, stomach contents, temporal variation.

INTRODUCTION

Research on the feeding biology of Brazilian birds was mainly shaped by pioneers more than half a century ago, such as Moojen *et al.* (1941), Hempel (1949) and Schubart *et al.* (1965), who analyzed stomach contents of various species based on few specimens. However, the interest of Brazilian ornithologists on the diets of birds was not revived until the 1990's. Since then, publications about avian diets have seen a significant increase. In general, more recent studies either focus on questions regarding herbivory/frugivory (Francisco & Galetti 2001, Chatellenaz 2008, Silva & Melo 2011), community studies, especially in Atlantic Forest (Durães & Marini 2005, Lopes *et al.* 2005, Lima *et al.* 2010), or place their focus on unusual food items found in the stomach of a small number of specimens (*e.g.*, Andrade *et al.* 2001), while collecting data for other purposes (Pacheco & Gonzaga 1995).

Other areas of interest, such as the detailed description and quantification of items found in the diet of Neotropical bird species as well as their correlations with environmental variables, have been neglected (but see Chapman & Rosenberg 1991, Biondi *et al.* 2005, Zilio 2006, Cabral *et al.* 2006, Fernandes 2007). Especially significant aspects of avian diets, such as seasonality, often fail to be addressed. However, birds in seasonally well–defined environments may change their diet (Bucher *et al.* 2003) and/or foraging strategy (Hejl & Verner 1990) according to changes in food availability. This theme is already well known for temperate birds, where changes in environmental aspects are considered to be more dramatic. Nevertheless, it is still poorly discussed in Neotropical ornithology despite the diversity of species and environments of this region. Most tropical biomes have more stable conditions regarding changes in the environment when compared to temperate ones. However, some suffer abrupt changes of conditions along the year especially related to rainfall, as it is the case of the Brazilian Cerrado and *Caatinga* dry forests.

Within this framework, the Silvery-Cheeked Antshrike, *Sakesphorus cristatus* (Wied, 1831), is a bird species endemic to the Brazilian driest biome, the *Caatinga*. It is locally common at the understory and mid-story stratum (Stotz *et al.* 1996) of lower growth and edges of deciduous woodlands and arid scrubs (Ridgely & Tudor 2009) that typically compose the *Caatinga*. These birds are usually seen in pairs in mixed flocks next to *Megaxenops parnaguae* Reiser 1905, *Myrmorchilus strigilatus* (Wied, 1831), *Taraba major* (Vieillot, 1816), *Herpsilochmus pileatus* (Lichtenstein, 1823), *Cantorchilus longirostris* (Vieillot, 1819) and *Formicivora melanogaster* Pelzeln, 1868 (Sick 1985, Teixeira *et al.* 1991, Olmos 2010). The Silvery-Cheeked Antshrike is considered a typical insectivorous bird, however, there is no research on its diet and foraging behavior. Available information is deduced from research on diverse species within the genus *Sakesphorus* (Zimmer & Isler 2003) and therefore based on speculation. In order to address this gap, the present paper qualifies and quantifies food items found in the diet of the *Sakesphorus cristatus* during the rainy as well as the dry season. Moreover, the paper aims to outline a correlation between the findings and the extreme environmental conditions specifically found in the *Caatinga*. Besides being the first record on *S. cristatus*' diet, the present paper is also the first to analyze the diet and its seasonal variation based on stomach contents of a bird in the *Caatinga* biome.

METHODS

Study area

The area of the *Caatinga* is estimated to cover 800,000 km² (IBGE 1985), encompassing all northeastern states of Brazil as well as the northern part of Minas Gerais (Figure 1A). Historically, the area has been considered a poor environment regarding species richness (compared to other Brazilian biomes), neglecting the significant number of endemic species. The *Caatinga* has an extreme and irregular rainfall regime, with dry periods lasting up to eight months (Sick 1985, IBGE 2010). Dry and rainy seasons are clearly distinct, but rainfall is irregular and seasonal, leading to a complex dynamic environment. This biome is still poorly studied in many aspects, among them, avian diet as well as feeding adaptations to survive in those extreme conditions.

The analyzed bird specimens were collected in the municipality of São Félix do Coribe, Bahia State, not specifically for the purpose of this study. The study site is located at 13°20'3.19"S 43°48'24.12"W, near the Corrente River, a tributary of the São Francisco River (middle region of São Francisco). The local vegetation is characteristic of the *Caatinga* morpho-climatic domain (Veloso *et al.* 1991) and comprises a native secondary vegetation of shrubby dry forests in early stages of development. (Figure 1B, C).

Collection of data

For the study, the contents of 72 stomachs, which are housed at the collection of Museu Nacional, Universidade Federal do Rio de Janeiro, were analyzed. Twenty nine of these were collected in April 2010, 29 in April 2011 at the beginning of the dry season, and 14 in November 2010 at the beginning of the rainy season. The complete list of specimens can be found in the Appendix. As a reference for the rainfall index, the city of Correntina, Bahia, was chosen as the area closest to the data collection site. Data were collected from the INMET (Instituto Nacional de Meterologia / National Institute of Meteorology) website.

The stomach contents of each specimen were analyzed with a stereo microscope *hund Wetzlar h* 33/10x. Prey items in each sample were identified, counted and preserved in 70% alcohol. Some of the fragments were photographed in the Laboratório de Entomologia, Universidade Federal do Rio de Janeiro, to support the identification of arthropods in future works.

Food items were identified to the lowest possible taxonomic level and categorized to Order level for statistical analysis. Formicidae (within Hymenoptera) and seeds had their own categories. The category Hymenoptera included the non-Formicidae and possible Formicidae that could not be accurately identified. The identification was done based on specialized literature (Borror *et al.* 1989, Costa *et al.* 2006, Rafael *et al.* 2012), visits to the entomological collection of the Universidade Federal do Rio de Janeiro, as well as photographs and illustrations of fragments presented in other works on the diet of birds (Ralph *et al.* 1985, Chapman & Rosenberg 1991, Gomes *et al.* 2001, Manhães *et al.* 2010). Most of the arthropods were very fragmented, so body parts were associated by morphological similarities and counted to estimate the minimum number of individuals of each category present in the sample. Seeds were counted individually. Each seed or individual prey was counted as one item.

A natural bias of diet studies based on stomach

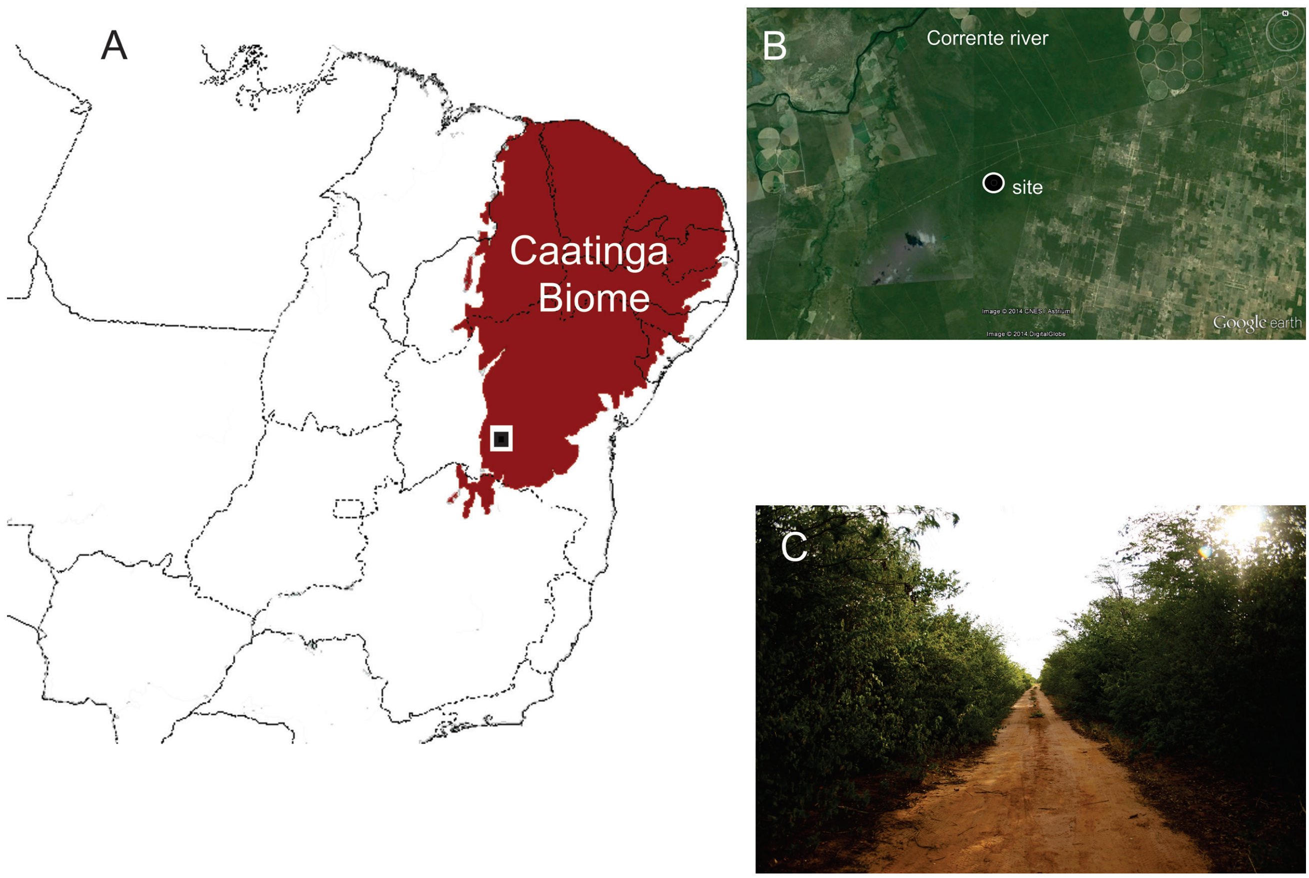

FIGURE 1. Map showing the study site and the extension of the *Caatinga* Biome in Brazilian territory (A). Close up of Google Earth satellite view of the study site location (B). Picture of the shrubby *Caatinga* forest fragment at the study site (C).

contents cannot be avoided, as the digestion of soft bodied arthropods, such as termites, is faster than the digestion of hard bodied arthropods, such as beetles (Dillery 1965, Rosenberg & Cooper 1990). Nevertheless, sclerotized parts, such as the jaws of termites and the chelicerae of spiders, remain in the sample even after the rest of the body was digested (Chapman & Rosenberg 1991).

Statistical analyses

The method proposed by Durães & Marini (2005) was applied to verify if the sampling was properly representing the diet of the species. Using *Estimates version 8.2*, sampling adequacy of each season was assessed by building cumulative curves with two different parameters: diet diversity (DD) (using Shannon index) and the associated coefficient of variation (CV) (Shannon index standard deviation/DD). Firstly, a sample was selected randomly and its diet diversity index was calculated. Secondly, a second sample was added and the index of both samples was calculated. The procedure was repeated without replacements of samples until all samples were added. After 100 runs, the DD of each round was calculated based on their mean value. The CV was calculated from the DD mean values. Adequacy was inferred by visual inspection of diet diversity curve and by the hypothesis of Durães & Marini (2005), which states that samples are adequate when the coefficient of variation reaches 15%. The importance of each category in the diet was estimated using a modified Alimentary Importance index (AI_i) of Kawakami & Vazzoler (1980). This index considers the relative abundance and occurrence of each category, thus reducing the bias caused by items that either occur frequently, but in small numbers or items that occur sporadically, but in great quantities. This index was calculated by the equation stated below, in which RO_i is the relative occurrence and $\overline{RA_i}$ the mean relative abundance of each category ($_i$). The RO_i was calculated by dividing the number of samples occurring in one category by the total sample number ($_n$). The relative abundance (RA_i) was calculated by dividing the number of items of a certain category by the total of items of that sample. In a next step, the $\overline{RA_i}$ of each category was obtained by adding the RA_i among the samples and dividing it by the total sample number.

$$AI_i = \left(RO_i \text{x } \overline{RA_i} / \sum_{i=1}^{n} (RO_i \text{x} \overline{RA_i}) \right) \text{x } 100$$

The software *PAST 2.17c* (Hammer *et al.* 2001) was used to verify the suspected existence of annual diet variations between the dry seasons of 2010 and 2011, and seasonal diet variations between dry and rainy season of 2010. A multivariate Non-Parametric MANOVA

(PERMANOVA), which explores the power of a multivariate analysis and Mann-Whitney's U test of each category, was used to assess the level of significance of variations. A P level of 0.05 was used for all statistical tests and Bonferroni correction was applied when multiple statistical comparisons were done. A Non-Parametric test was used because data did not meet the homoscedastic and normality assumption.

Regarding the evaluation of sampling adequacy methods, our coefficient of variation was in agreement with the parameters of Durães & Marini (2005). In both periods the coefficient of variation was 10% or less when the diversity curve stabilized, thus below the proposed 15% threshold (Figure 2). Our results match the ones obtained by Durães & Marini (2005) for Atlantic Forest birds and those by Chapman & Rosenberg (1991) for Amazonian Woodcreepers. According to the method, eight to ten samples were enough to statistically estimate the diet of Silvery-Cheeked Antshrike in the shrubby *Caatinga* in both periods.

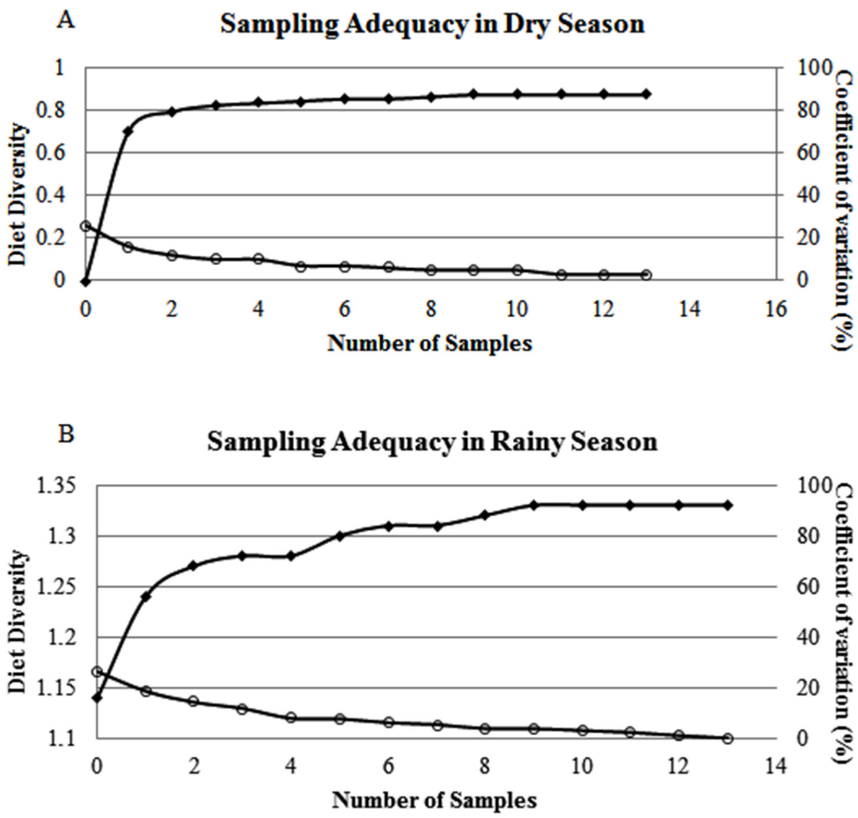

FIGURE 2. Diet diversity (DV, black squares) and coefficient of variation (CV, white circles) of the diet of the Silvery-Cheeked Antshrike (*Sakesphorus cristatus*) in the dry and wet seasons. The graphs show that both seasons had adequate minimum sampling to estimate the species diet during those periods. The greater index of diet diversity during the rainy season when compared to the dry season, shows a greater equitability between the different categories consumption rate in the diet during the rainy season.

RESULTS

A total of 6,244 items belonging to 16 categories were identified. In both seasons, there was a predominance of the following categories: Formicidae (ants), Isoptera (termites) and Coleoptera (beetles: A, Adult). Relative abundance and occurrence, food importance index and average items per sample of the different categories are shown in Table 1.

Dry season

We recorded 5,630 items in the 58 dry season samples. The minimum number of items found in one sample was 15, the maximum was 293, and the average was 95.03 items/sample.

Formicidae had the highest rates for all indexes during the dry season. It was present in all samples, which is an extremely significant result considering that 58 stomachs were analyzed. The maximum number recorded was 258 ants in a single specimen. Isoptera was the second most representative category; it also showed high numbers for all analyzed indexes and the maximum number of individuals in a single sample was 181. Coleoptera (A) had much lower index values compared to the previous two categories; nevertheless, beetles were present in 54 of 58 samples.

The other categories had an AI_i equal or less than 1% and were considered rare or sporadical items, including the following: seeds, Coleoptera (L, larvae), Lepidoptera (adults, A, and larvae, L), Hemiptera, Araneae, Pseudoscorpiones, Neuroptera (larvae), Diptera, Chilopoda, Thysanoptera, Acari and Hymenoptera. Five

TABLE 1. Arthropods in the diet of the Silvery-Cheeked Antshrike (*Sakesphorus cristatus*). All parameters calculated for each season and category based on 72 stomach samples. (A) adult, (L) larvae.

Category	Importance Index (%)		Relative abundance (%)		Relative occurrence (%)		Average of consumption (Items/sample)	
	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season
Formicidae	64.19	29.69	58.30	27.85	100	93	56.60	12.21
Isoptera	31.63	50.26	36.89	50	97	100	35.81	21.79
Coleoptera (A)	3.34	12.26	2.71	10	93	93	2.64	4.14
Hymenoptera	0.73	0.24	1.20	0.82	48	29	1.17	0.29
Lepidoptera (L)	0.06	6.05	0.24	7	24	64	0.24	3.07
Araneae	0.01	0.69	0.14	0.89	10	29	0.14	0.36
Pseudoscorpiones	0.01	0.19	0.09	0.82	7	21	0.09	29
Chilopoda	0.01	0.00	0.09	0	9	0	0.07	0
Coleoptera (L)	0	0.24	0.04	0.99	3	21	0.04	0.43
Lepidoptera (A)	0	0	0.02	0	2	0	0.02	0
Hemiptera	0	0.06	0.05	0.33	5	14	0.05	0.14
Neuroptera (L)	0	0.17	0.04	0.82	3	14	0.03	0.29
Diptera	0	0.16	0.04	0.33	3	0	0.04	0.14
Thysanoptera	0	0	0.02	0	2	0	0.02	0
Acari	0	0	0.04	0	3	0	0.04	0

seeds in four of 58 samples were found, all apparently being of the same species considering the morphological similarity. The diet diversity index was 0.87.

The NP-MANOVA did not show significant difference in consumption of prey between dry seasons on different years (p<0.56), neither did Mann-Whitney's U test for the categories individually. Consumption of items was slightly higher in 2011 than in 2010. We recorded 2,983 items in 2011 (mean = 102.86 individuals/sample) versus 2,648 in 2010 (mean 91.31 individuals/sample).

Rainy season

We identified 614 items in 14 samples. The minimum number of items per sample was eight, the maximum was 82, and the average was 39.74. Isoptera was the most important category (AI_i), occurring in all samples, followed by Formicidae and Coleoptera (A). Another important category was Lepidoptera (L, larvae) (Table 1), even though its indexes were not as significant as the latter categories. Their average consumption was 3.07 individuals/sample, a number similar to that of adult beetles. The other categories summed up 6% of the items found. Chilopoda, Thysanoptera, Lepidoptera (A) and seeds were not recorded in this season. The diet diversity index was 1.33.

Seasonal variation

The NP-MANOVA showed a significant difference in consumption of prey between seasons (p<0.00). The categories that had an acceptable significance level of variation by Mann-Whitney's U test were Formicidae (U = 42, Z= 4.98 , p <0.00), Coleoptera (A) (U = 250.5, Z= -1.88, p <0.04), Lepidoptera (L) (U = 190, Z= -3.37, p <0.00) and Araneae (U = 293.5, Z= -2.15, p <0.03). The basic statistics can be found in Table 2. There was an abrupt decrease of the total average consumption per specimen with fewer items being consumed during the rainy season than the dry season. The two main categories (Formicidae and Isoptera) had considerable reduction in the average consumption, while Coleoptera (A) and Lepidoptera (L) increased significantly. Regarding consumption of ants, the relative abundance (from 58 to 28%) and the average consumption (from 56.60 to 13.15 individuals/sample) reductions were dramatic. Despite the reduction of average consumption, the second most abundant and important (AI_i) category during dry season, Isoptera, had one of the highest rates in the rainy season. Regarding Lepidoptera (L), this increase is particularly striking: the AI_i increased from 0.06 to 6.05% and the average consumption from 0.24 to 3.07 individuals/sample. There was also an increase in the importance index of nine out of 16 prey categories, indicating a greater diversity of the diet during the rainy season. This increase in the diet diversity is also supported by the diet diversity index variation (dry = 0.87; rainy = 1.33) (Figure 2A, B).

Sampling adequacy

The curves of sampling adequacy showed that both, the dry and the rainy season samplings, were stabilized and thus properly estimated the diet of *S. cristatus* during those periods (Figure 2A, B). In the dry season, the curve began to stabilize with only three or four samples, when the coefficient of variation (CV) reached 10% and completely stabilized with nine samples (CV = 5%). For the rainy season, sampling was stabilized with nine samples, when the CV was 5%.

TABLE 2 (1). Basic statistics for each item in dry and rainy season in the diet of the Silvery-Cheeked Antshrike (*Sakesphorus cristatus*).

	Isoptera	Formicidae	Hymenoptera	Coleoptera	Lepidoptera	Hemiptera	Araneae
Dry season							
n	58	58	58	58	58	58	58
Min	0	7	0	0	0	0	0
Max	181	259	7	7	1	1	3
Sum	2069	3189	63	147	15	3	7
Mean	35.67	54.98	1.08	2.53	0.25	0.05	0.12
Standard error	4.89	4.77	0.22	0.22	0.05	0.02	0.06
Variance	1391.13	1324.47	2.95	2.81	0.19	0.04	0.21
Standard deviation	37.29	36.39	1.71	1.67	0.44	0.22	0.46
Coefficient of variation	104.55	66.19	158.32	66.19	170.79	431.91	382.62
Rainy season							
n	13	13	13	13	13	13	13
Min	1	0	0	0	0	0	0
Max	56	48	1	9	8	1	2
Sum	248	156	4	54	38	2	5
Mean	19.07	12.00	0.30	4.15	2.92	0.15	0.38
Standard error	4.62	3.4	0.13	0.77	0.87	0.1	0.18
Variance	278.07	150.66	0.23	7.8	9.91	0.14	0.42
Standard deviation	16.67	12.27	0.48	2.79	3.14	0.37	0.65
Coefficient of variation	87.41	102.28	156.12	67.26	107.69	244.09	169.11

TABLE 2 (2). Basic statistics for each item in dry and rainy season in the diet of the Silvery-Cheeked Antshrike (*Sakesphorus cristatus*).

	Pseudoscorpiones	Neuroptera	Diptera	Chilopoda	Thysanoptera	Acari	Seeds
Dry season							
n	58	58	58	58	58	58	58
Min	0	0	0	0	0	0	0
Max	2	1	1	1	1	1	1
Sum	5	2	2	4	1	2	3
Mean	0.08	0.03	0.03	0.06	0.01	0.03	0.05
Standard error	0.04	0.02	0.02	0.03	0.01	0.02	0.02
Variance	0.11	0.03	0.03	0.06	0.01	0.03	0.04
Standard deviation	0.33	0.18	0.18	0.25	0.13	0.18	0.22
Coefficient of variation	393.79	533.77	533.77	370.63	761.57	533.77	431.91
Rainy season							
n	13	13	13	13	13	13	13
Min	0	0	0	0	0	0	0
Max	2	3	1	0	0	0	0
Sum	4	4	2	0	0	0	0
Mean	0.3	0.3	0.15	0.00	0.00	0.00	0.00
Standard error	0.17	0.23	0.1	0.00	0.00	0.00	0.00
Variance	0.39	0.73	0.14	0.00	0.00	0.00	0.00
Standard deviation	0.63	0.85	0.37	0.00	0.00	0.00	0.00
Coefficient of variation	204.88	277.82	244.09	0.00	0.00	0.00	0.00

Arthropod composition

We identified at least 13 ant morphotypes. Among the identified genera, there were *Cephalotes* (Figure 3A), *Pheidole* (Figure 3B) and *Odontomachus* (Figure 3C). At least three morphotypes of *Cephalotes* were identified, making it one of the most frequent and abundant preys in the diet of *S. cristatus*. In contrast, winged ants were rare. Regarding termites, we found the castes of workers (Figure 3D) and soldiers (Figures 3E and 4D), with workers being the most frequent and abundant. No winged termite was found. Among the families of beetles, Curculionidae (Figures 3F and 4E), Chrysomelidae, Cerambycidae, Nitidulidae, Tenebrionidae and Scarabaeoidea (superfamily) were found. Among these taxa, Tenebrionidae, Scarabaeoidea and Nitidulidae are predominantly detritivores and the others are phytophagous. The most common beetle taxa were Curculionidae, Chrysomelidae and Cerambycidae, and among these, two morphotypes of the tribe Naupactini (Curculionidae) (Figure 3F) were extremely common and identified in most samples. Among the non-Formicidae Hymenoptera, wasps (Vespidae) and bees (Apidae) were found.

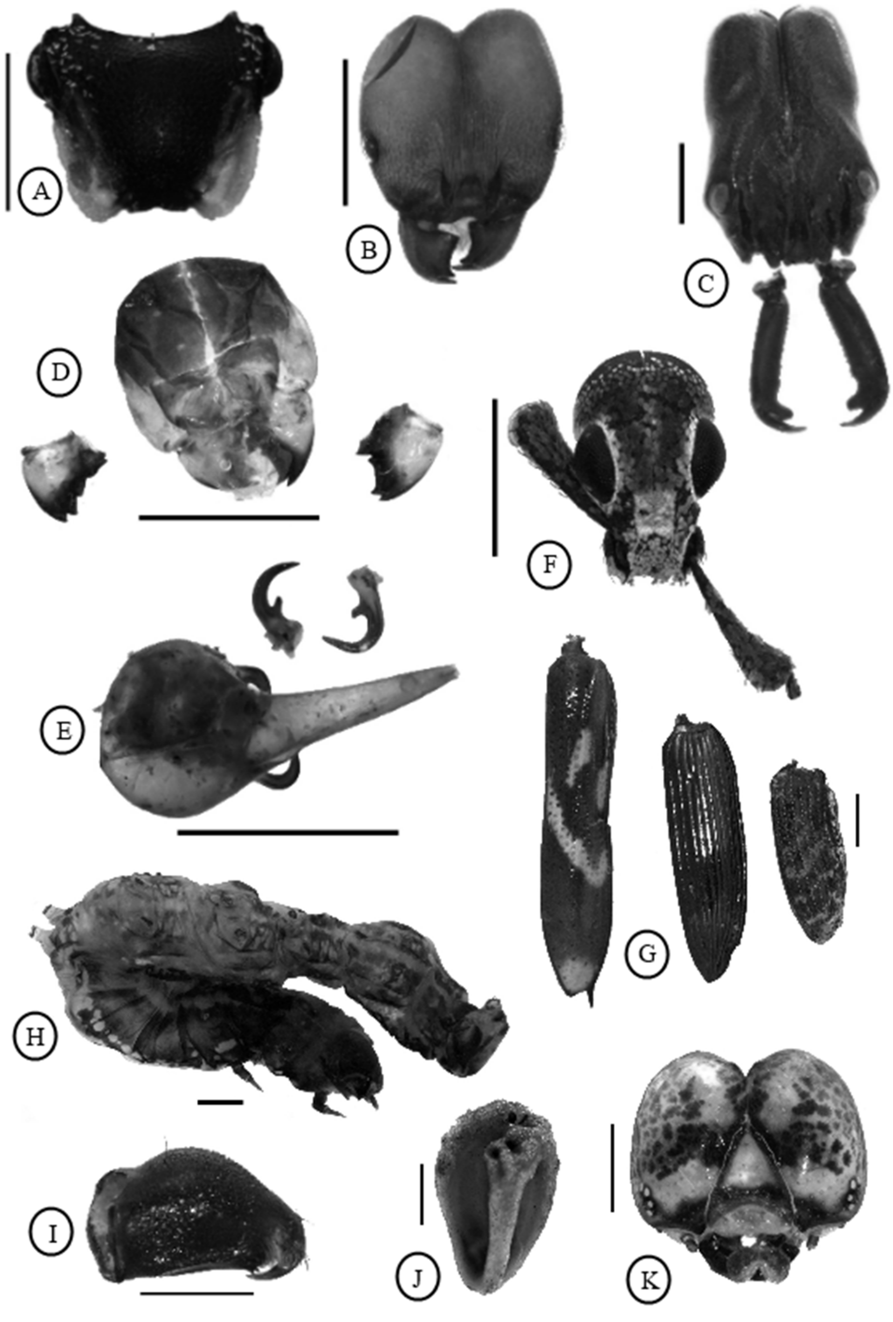

FIGURE 3. Arthropod fragments from the stomach contents of the Silvery-Cheeked Antshrike (*Sakesphorus cristatus*). A total of 72 stomachs were sampled. A: *Cephalotes sp.* (Formicidae); B: *Pheidole sp.* (Formicidae); C: *Odontomachus* sp. (Formicidae); D: Worker termite (Isoptera); E: Soldier termite (Isoptera); F: Weevil's head (Curculionidae: Naupactini); G: Sorts of elytra (Coleoptera); H: Caterpillar (Lepidoptera, L); I: Chelicerae (Araneae); J: Seed; K: Caterpillar's head (Lepidoptera, L). Scale bar = 1mm.

The identified spiders belong to Theraphosidae (tarantulas) (Figure 4I), one of them remarkably large, as well as Salticidae (jumping-spiders) and Thomisidae (crab spiders). The hemipterans were rare and very fragmented but the ones we could identify were either lace Tingidae (bugs) or Auchenorrhyncha (cicadas), both typically sap-sucking phytophages. The only dipteran found was a Brachycera (fly) (Figure 4H).

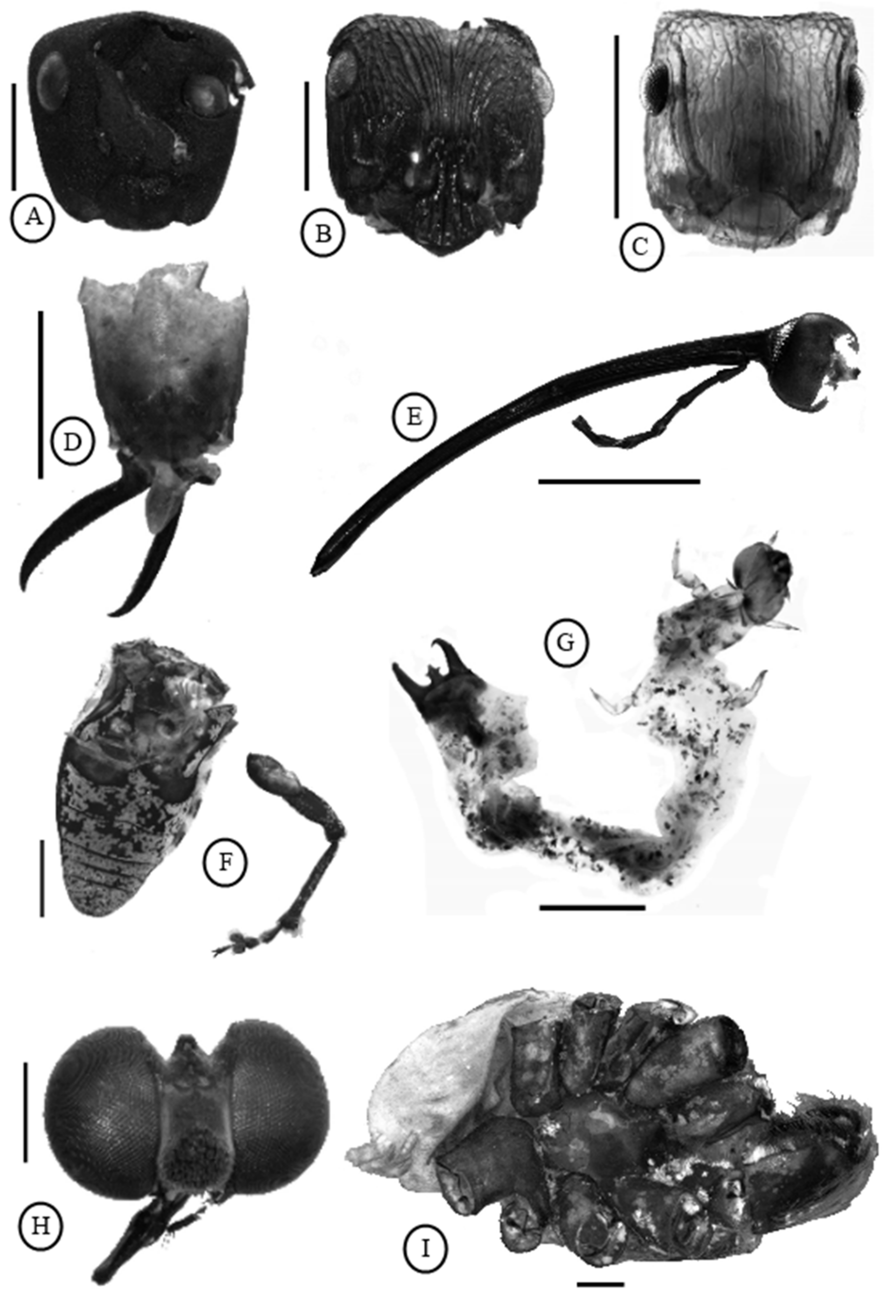

FIGURE 4. Arthropod fragments from the stomach contents of the Silvery-Cheeked Antshrike (*Sakesphorus cristatus*). A total of 72 stomachs were sampled. A-C: Ants (Formicidae); D: Soldier termite (Isoptera); E: Weevil's head (Curculionidae: Erodiscinae); F: Weevil's abdomen and leg (Curculionidae); G: Coleoptera larva; H: Fly (Diptera: Brachycera); I: Tarantula (Araneae: Theraphosidae). Scale bar = 1mm.

DISCUSSION

Our data confirmed that the Silvery-cheeked Antshrike is a predominantly insectivorous species. We found that the proportion and occurrence of consumption of the different categories of prey varies significantly between seasons. The taxa most commonly identified were Formicidae, Isoptera, Coleoptera (A) and Lepidoptera (L). Three of these are reported as typical food for Thamnophilidae (Gomes *et al.* 2001, Durães & Marini 2005, Lopes *et al.* 2005, Aguiar & Coltro-Júnior 2008, Manhães & Dias 2008, Lima *et al.* 2010), while apterous termites, one of the most important categories in our study, have not been commonly mentioned in the literature so far, especially not in such great quantities/proportions.

Our results show that ants are one of the key resources to the bird species under study and probably to other birds in *Caatinga*. Their importance was already suggested in previous studies on neotropical birds (Gomes *et al.* 2001, Aguiar & Coltro-Júnior 2008, Lopes *et al.* 2005) and is attributed to their natural abundance (Poulin & Lefebvre 1997, Durães & Marini 2005). Nevertheless, they were the most consumed category during the dry season, when availability of insects and other arthropods in *Caatinga* is extremely low. For nearly all arthropods studied in this biome, there was much greater abundance during rainy season (Vasconcellos *et al.* 2007, Santos *et al.* 2009, Araújo *et al.* 2010a, Araújo *et al.* 2010b, Vasconcellos *et al.* 2010, Oliveira *et al.* 2011) with strong positive correlation with rainfall and relative humidity. The ant populations, however, have an abundance pattern opposite of other insects. Their peak of abundance and activity is during the dry season (Nunes *et al.* 2011, Medeiros *et al.* 2012), which makes them an extremely important resource during this time of the year.

Although apterous termites are not commonly reported in diet studies of neotropical birds as important prey, we found them in our study to be an essential food resource. These insects play a very important role not only in the diet of the Silvery-cheeked Antshrike but in the other *Caatinga* birds since many other bird species of the same area consume them widely (NBN unpublished data). This matches the findings of other vertebrates previously studied in arid/semi-arid environments, including birds, reptiles, amphibians and bats (Advani 1982, Poulin *et al.* 1994, Griffiths & Christian 1996, Gibson 2001, Cabral *et al.* 2006, Hardy & Crnkovic 2006, Kolodiuk *et al.* 2010). Its absence in diet studies is probably due to the difficulty of identifying them, or perhaps the small number of studies made with semi-arid environments' species. Because their body is extremely soft and thin, body parts are quickly digested leaving only their mandibles, which may be confounded with the ones of other insects.

Despite their low abundance, coleopterans were identified in 93% of all samples in both seasons. Their ubiquitousness in studies on the diet of thamnophilids shows that coleopterans are, indeed, essential resources for these birds. Nevertheless, even though they were very frequent in this study, their relative abundance in the diet of Silvery-cheeked Antshrike was very low compared to those obtained in studies of thamnophilid birds in other biomes such as the Amazon and Atlantic Forests (Lopes *et al.* 2005, Vasconcelos *et al.* 2007, Aguiar & Coltro-Júnior 2008). Their presence and predominance in diet studies of birds is often attributed to their hard bodies and the difficulty of digestion of the elytra, which would facilitate the detection of this group (Willis & Oniki 1978). However, that did not happen in the case of *S. cristatus*, where Formicidae and Isoptera were much more abundant. Beetles are either less important for the diet of *S. cristatus* compared to other birds, or underestimated by the lack of a method concerning the mass of each category.

Caterpillars were the fourth most consumed category during the rainy season, but still very relevant in *S. cristatus* diet. Because they are energetically rich and soft bodied they are considered one of the most important food sources for nestlings (Yard *et al.* 2004), as well as for the diet of many adult birds during rainy periods. The importance in the consumption of lepidopteran larvae during the breeding season has already been discussed by several authors, including studies in arid regions (Holmes 1990, Poulin *et al.* 1994, Yard *et al.* 2004, Biondi *et al.* 2005, Lopes *et al.* 2005). The higher consumption of lepidopterans during the rainy season was also observed in stomach contents of other bird species from the same study area (NBN unpublished data). Based on these results we suggest that these insects are also important for the breeding biology of *Caatinga* birds.

The other food categories consumed by Silvery-Cheeked Antshrike were much less numerous. Nevertheless, special attention should be given to the presence of fruits. Poulin *et al.* 1994) observed a higher consumption of fruits by many bird species in an arid region of Venezuela during the dry season, when arthropod abundance and water availability is critical. Even though consumption was very low and probably not significant to *S. cristatus* diet, this may be an evidence of opportunism and plasticity in the feeding behavior of species that live in extreme conditions of survival, such as food or water scarcity (Wendelken & Martin 1988, Poulin *et al.* 1994). Opportunistic and sporadic consumption of fruits during the dry season in other *Sakesphorus* as well as Thamnophilidae species has already been reported (Haverschmidt 1968, Poulin *et al.* 1994, Lima *et al.* 2010).

The diet of Silvery-Cheeked Antshrike seems to be associated with availability of food, which in turn, is most positively correlated with rainfall and relative humidity (except for Formicidae). During the dry season, its diet relies mainly on resources that are able to maintain their population, as in the case of ants and termites. On the other hand, during the rainy season, it consumes more energy-rich food, such as caterpillars and beetles. Even though we did not conduct an insect survey of the area, other studies on insect population fluctuation in the *Caatinga* support our results confirming that the insects consumed by *S. cristatus* are in fact quite abundant during those periods of time (Vasconcellos *et al.* 2007, Santos *et al.* 2009, Araújo *et al.* 2010a, Araújo *et al.* 2010, Vasconcellos *et al.* 2010, Oliveira *et al.* 2011, Nunes *et al.* 2011, Medeiros *et al.* 2012).

Studies on feeding biology, along with others such as breeding biology, taxonomy, and distributional patterns, provide the most basic knowledge about a bird's natural history. This, in turn, comprises the fundamental resource for the conservation of species and environments. The fact that our results are the first information based on stomach contents of any bird in *Caatinga*, being the species addressed one of the most common in the biome, draws attention to a bigger, problematic scenario. Even though our scientific collections and study methods have significantly improved since the work of Moojen *et al.* (1941), many species lack basic information about their natural history. Although this is especially true for birds in *Caatinga*, there still remains a gap for many other species. Thus, we emphasize the need to increase the number of studies focusing on the basic knowledge of Neotropical birds as well as the use of specimens housed in scientific collections.

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APPENDIX

Access numbers of specimens of the Silvery-Cheeked Antshrike (*Sakesphorus cristatus*) whose stomachs were analyzed in this study.

Dry season - 2010: MNA 5169; MNA 5172; MNA 5195; MNA 5219; MNA 5228; MNA 5256; MNA 5266; MNA 5270; MNA 5279; MNA 5286; MNA 5309; MNA 5312; MNA 5319; MNA 5322; MNA 5332; MNA 5333; MNA 5336; MNA 6422; MNA 6445; MNA 6488; MNA 6519; MNA 6520; MNA 6713; MNA 6730; MNA 6742; MNA 6872; MNA 7043; MNA 7061. **2011**: MNA 7065; MNA 5268; MNA 7067; MNA 7056; MNA 7055; MNA 7054; MNA 7045; MNA 6901; MNA 6898; MNA 6896; MNA 6735; MNA 6727; MNA 7060; MNA 7059; MNA 6909 ; MNA 6899; MNA 6893; MNA 6739; MNA 6738; MNA 7382; MNA 7258; MNA 7254; MNA 7066; MNA 7051; MNA 6921; MNA 6741; MNA 6733; MNA 6736.
Rainy season - 2010: MNA 5272; MNA 7024; MNA 7025; MNA 7028; MNA 7030; MNA 7032; MNA 7035; MNA 7036; MNA 7039; MNA 7047; MNA 7048; MNA 7049; MNA 7057; MNA 7062.