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Breeding biology, diet and vocal repertoire of White-rumped Monjita *Xolmis velatus*

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Summary.—Although generally common in parts of eastern and southern South America, the biology of White-rumped Monjita *Xolmis velatus* is poorly known. We aimed to augment existing knowledge with previously unpublished data concerning its breeding biology, diet and vocal repertoire. We studied three nests and one encounter outside the nest. To complement our field data, we searched the literature and 7,895 media submitted to online citizen science platforms. We present a list of food items consumed by the species and provide the first detailed description of its vocal repertoire, identifying four different call types. All nests were cups sited low above ground (0.3–4.0 m). The breeding season in Brazil extends at least from June to January. In two nests, more than one adult fed the nestlings. At one, nestlings were fed insects of six orders (mainly Coleoptera), spiders, earthworms, one myriapod, and a lizard (*Kentropyx* aff. *paulensis*).

White-rumped Monjita *Xolmis velatus* (Tyrannidae) occurs in Argentina, Brazil, Bolivia and Paraguay (de la Peña 2019, Farnsworth & Langham 2020), in open areas such as grasslands and savannas (Farnsworth & Langham 2020). Although common in many areas, its biology is poorly known (see Farnsworth & Langham 2020), and knowledge of breeding is confined to a few reports, mainly by Buzzetti & Silva (2008), Lombardi *et al*. (2010) and Lopes *et al*. (2013). The species' foraging behaviour has been described in detail recently (Ferrari *et al*. 2023), but dietary data remain scarce, with the most accurate information reports of stomach contents by Moojen *et al*. (1941) and Schubart *et al*. (1965). As a species that vocalises unpredictably after long intervals of silence, there are few recordings available in publicly accessible databases, and its vocal repertoire and functions are still incompletely known. Our objective here is to report unpublished data concerning its breeding biology, diet, and vocalisations.

Material and Methods

Data collection in the field.—To obtain information on breeding biology and diet, we studied three nests found by chance between November 2008 and October 2021, and an encounter with a fledgling in 2021. Nest 1 was found on 15 November 2008 in the municipality of Analândia (22º07′30″S, 47º39′40″W), state of São Paulo, Brazil; nest 2 on 9 October 2010 in the municipality of Marília, São Paulo (22º08′07″S, 49º53′52″W); and nest 3 on 20 October 2021, at Sítio Nossa Senhora de Fátima, Rio Claro, São Paulo (22°25′37″S, 47°37′41″W). At the last nest, we made 12 hours of focal observations (Altmann 1974) during 20–29 October 2021, noting the time and duration of each provisioning event, the food delivered to nestlings, and the adult involved. We photographed all food items

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to facilitate the most accurate identification possible. Nests were classified according to the nomenclature of Simon & Pacheco (2005) and measured with a calliper (accurate to 0.1 mm) and tape measure (1 mm). To study the species' vocal repertoire, we recorded the vocalisations given by three adults and one juvenile using a Tascam DR-40 recorder and Sennheiser ME67 microphone. We measured bioacoustic parameters using Raven Pro 1.6.3 software (Center for Conservation Bioacoustics 2019).

Analysis of citizen science databases.—We located 7,895 media of the species deposited on the online citizen science platforms WikiAves (www.wikiaves.com.br; 6,949 photos), Macaulay Library (www.macaulaylibrary.org; 777 photos and 14 videos) and iNaturalist (www.inaturalist.org; 155 photos) (archived prior to 27 October 2021). We identified photos of adults with nest material, active nests (either contents unknown, with eggs and/or chicks), fledglings, and individuals carrying food. To understand the species' vocal repertoire, we evaluated 61 sound recordings in the same databases to complement our analysis.

Results

Nest 1.—This nest (Fig. 1A) was a low cup/base sited under the roof of a house, *c*.2.5 m above ground, and held three well-grown nestlings. Two adults were observed feeding the young.

Nest 2.—This nest (Fig. 1B) was built in a hollow in a wooden fence, *c*.1 m above ground. At 13.15 h, we observed an individual enter the nest, which we classified as cavity/without tunnel/low cup containing dry grass, some feathers and cattail leaves. We returned on 23 October (i.e., 14 days after discovery) when it contained at least two white eggs (Fig. 1B).

Nest 3.—When found the third nest (Fig. 1C–F) contained at least two early-stage nestlings still with closed eyes. It was inside a 14-cm-diameter PVC pipe, 4 m above ground. It was a cavity/with tunnel/high cup located 67 cm from the pipe's entrance. The nest was constructed mainly of dry twigs, thicker at the base and thinner around the egg chamber, the latter lined with some plumes. On 20 October 2021, at 11.18 h, an adult arrived and fed the nestlings. Two minutes later, an adult was seen carrying a moth, which was ingested a few metres from the nest. On 22 October 2021, we observed two adults feeding

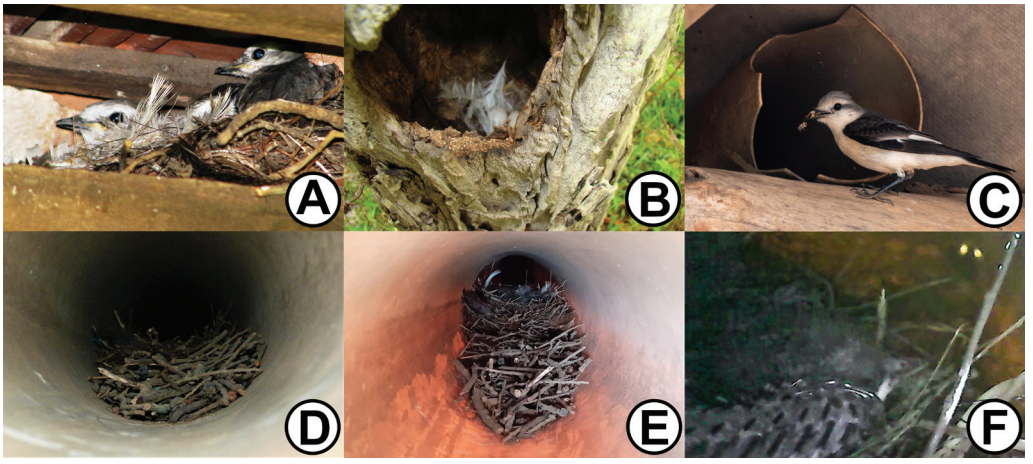

Figure 1. Nests of White-rumped Monjita *Xolmis velatus*. A: nest 1 with nestlings, Analândia, São Paulo, Brazil, 15 November 2008 (Rogério Carlos Machado); B: nest 2 with eggs, Marília, São Paulo, Brazil, 23 October 2010 (Manuel Gonzales); C–F: nest 3, Rio Claro, São Paulo, Brazil; C: adult at entrance to PVC pipe, 20 October 2021 (Luiz Ramassotti); D: nest, 29 October 2021 (Carlos Otávio Araujo Gussoni); E: nest with nestlings, 20 October 2021 (Carlos Otávio Araujo Gussoni); F: nestling, 22 October 2021 (Carlos Otávio Araujo Gussoni)

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the nestlings, at a rate of 14 visits/hour and a mean interval between visits of 247 seconds (SD = 282 seconds, min. 0 seconds, max. 1,306 seconds, median = 105 seconds, *n* = 51). On 25 October, the frequency of provisioning events increased to 32 visits/hour, at a mean interval of 104 seconds (SD = 228, min. 0, max. 792, median = 50, *n* = 111). On 29 October, the frequency was 16.75 visits/hour, at a mean interval of 177 seconds (SD = 228, min. 10, max. 1,085, median = 100, *n* = 62). Several times during these observations, we observed adults capture insects in the immediate environs of the nest, in the air or on the ground. In 30.07% of visits to the nest (*n* = 133 visits with identified items), more than one prey item was carried in the bill (Fig. 2B–C), whereas in the others just one item was brought. Of visits with more than one item, 60% involved two, 35% three, 2.5% four and 2.5% five (*n* = 40). The number of visits with multiple food items increased considerably over time: one on 22 October (06.40–10.40 h), 15 on 25 October (06.57–10.57 h) and 24 on 29 October (06.40–10.40 h). Six times, an adult landed on the edge of the nest but delivered the food to the other adult waiting nearby, and the latter fed nestlings. Table 1 shows food items delivered to the nestlings, as well as those ingested by the adults, on each day of focal observation. On 29 October, at 10.22 h, for the first time in the study, three adults were seen around the nest, but we were unable to verify if all three tended the nestlings. On 5 November, at 06.34 h, the nest was empty, indicating that the nestling period was less than 23 days, if the nestlings were between one and six days old when found, based on available data for White Monjita *X. irupero*, whose nestlings open their eyes aged between four and six days old (de la Peña 2019).

Among the 200 identified items (Figs. 2–3) brought to the nestlings in the 2021 nest, just four involved larvae. Of the remaining 196 items, insects accounted for 90.9%. The most frequent insect order in the nestlings' diet was Coleoptera (80.65%), followed by Orthoptera (9.7%), Lepidoptera (5.8%), Odonata (1.9%), Hemiptera (1.3%) and Blattodea (0.65%). Nine spiders, an earthworm, a myriapod and a lizard (*Kentropyx* aff. *paulensis*) were also delivered.

Removal of faecal sacs. Faecal sacs were removed on average 1.16 times/hour. On three occasions, the adult dropped faecal sacs on the ground after landing on a distant perch, and once the bird swallowed the faecal sac *c*.18 m away. Four times, the adult flew to electricity wires in the vicinity to drop the faecal sac on the ground, three times on a wire 18 m from the nest and once 30 m away. Twice the adult dropped the faecal sac on the ground in flight, *c*.18 m and 27 m from the nest. On six occasions, an adult flew off holding the faecal sac but we were unable to see where it was discarded.

Agonistic encounters near the nest. We recorded three agonistic encounters between adult monjitas and other birds in the vicinity of the nest. In one, an adult attacked a Great Kiskadee *Pitangus sulphuratus* and in another it attacked a Tropical Kingbird *Tyrannus melancholicus* on a mango tree *Mangifera indica*. The third encounter involved a Chestnut-capped Blackbird *Chrysomus ruficapillus*.

Breeding season.—Analysis of data on citizen science platforms and the literature, as well as data collected in the field, indicates that the breeding season in Brazil (Fig. 4) spans at least June–January. The earliest documented evidence of breeding in the year is of a nest in use (contents unknown) photographed on 10 June (WA 659766) and the latest a fledgling being fed by an adult on 6 January (WA 4408771). The earliest and latest records of each stage of the breeding cycle are presented in Table 2.

Nest sites.—Nests were sited in hollows in wood (including trees and fence posts; *n* = 7), termite mounds (*n* = 4), roofs/ceilings (*n* = 3; Lombardi *et al*. 2010; P. G. Costa *in litt*. 2021; this paper), pipes (*n* = 2; WA 3106991; this paper), a clump of orchids (WA 1045064), a hole in a rock wall (WA 2361169), an abandoned nest of a *Furnarius* sp. (Furnariidae, WA 430102) and a hole in an earth bank (WA 2385064, A. Constantini *in litt*. 2021).

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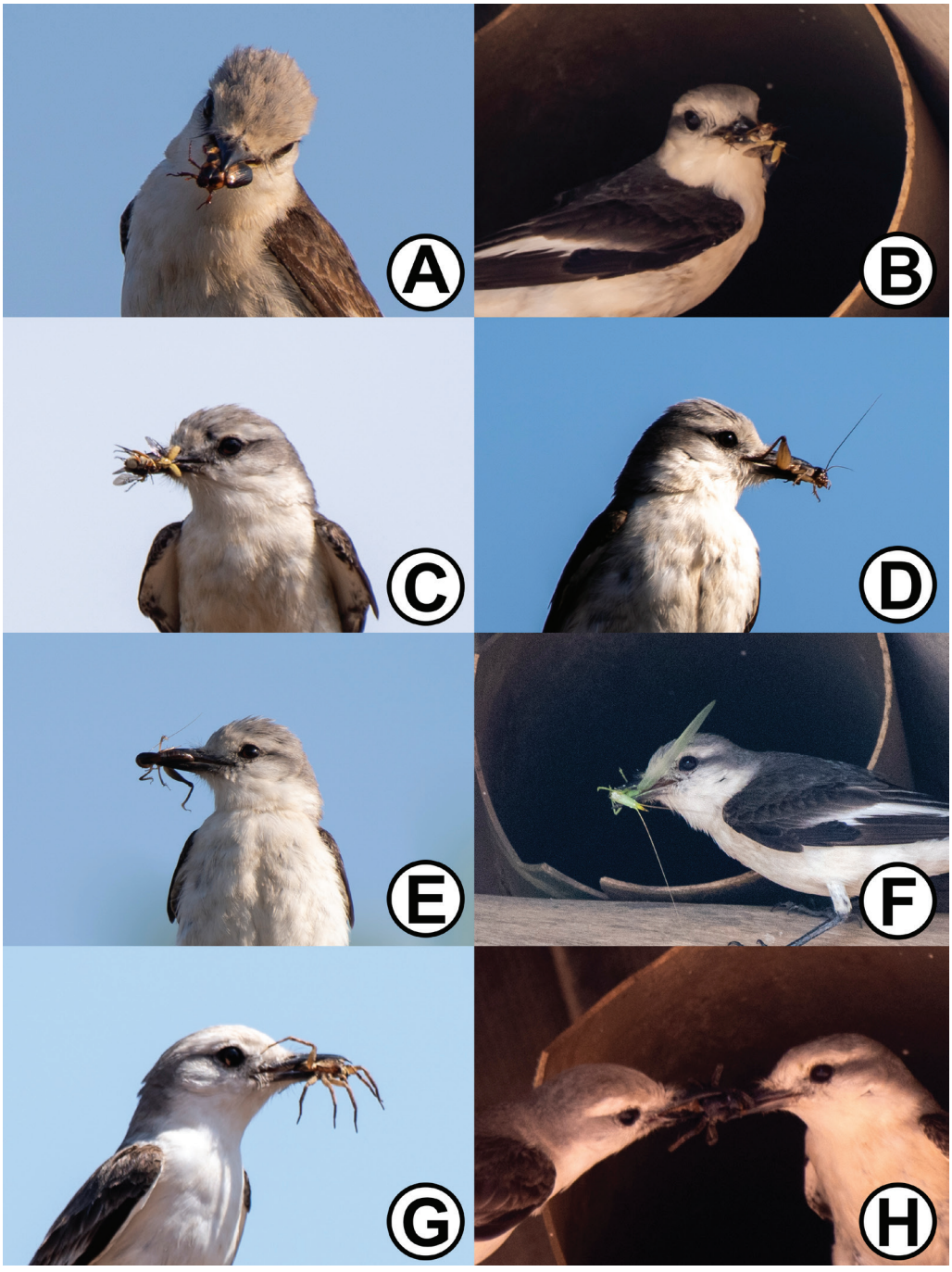

Figure 2. Food delivered to nestlings of White-rumped Monjita *Xolmis velatus*, Rio Claro, São Paulo, Brazil. A–C = Scarabaeidae; D = Grylloidea; E = Ensifera; F = Tettigoniidae, Conocephalinae, Copiphorini; G–H = Lycosidae (Luiz Carlos Ramassotti)

Vocal repertoire.—We present descriptions of those vocalisations that we heard. We did not find any vocalisations in citizen science databases additional to those we heard and recorded in the field.

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TABLE 1

Food (numbers indicate number of items) delivered to nestlings (N) and/or ingested by adults (A) of White-rumped Monjita *Xolmis velatus* during the present study, mentioned in the literature or recorded in photographs submitted to citizen science databases (WikiAves, Macaulay Library, and iNaturalist). Nomenclature follows ITIS (2023) and World Spider Catalog (2022). Literature: a. Moojen *et al*. (1941), b. Schubart *et al*. (1965), c. Gimenes *et al*. (2007), d. Krabbe (2007), e. Buzzetti & Silva (2008). *Scarabaeidae prey in Rio Claro included several *Macrodactylus* cf. *pumilla* (not quantified) and an *Onthophagus* sp. **Described as 'lagartas' ('caterpillars').

Food items	Oct 20 (N)	Oct 20 (A)	Oct 22 (N)	Oct 22 (A)	Oct 25 (N)	Oct 25 (A)	Oct 29 (N)	Oct 29 (A)	Literature	Citizen science databases
Araneae (unidentified)									c	5
Araneae: Lycosidae			7				1			
Blattodea (unidentified)					1					
Diptera: Brachycera									c	
Coleoptera (unidentified)			3		30	2	6		a,c	6
Coleoptera: Curculionidae									b	
Coleoptera: cf. *Dascillus* sp.			1							
Coleoptera: Scarabaeidae*	3		4		12		62	1	b	
Coleoptera: Staphylinidae							1			
Hemiptera: Homoptera									b	
Hemiptera: *Zammara tympanum*							2			
Hemiptera: Reduvioidea									b	
Hymenoptera (unidentified)									a	
Hymenoptera: Vespoidea									b	
Lepidoptera excluding Papilionoidea (moths)		1	3	2	2		1			1
Odonata: Libellulidae							1			
Odonata: *Erythemis vesiculosa*			1		1					
Orthoptera (unidentified)							1		a	5
Orthoptera: Acrididea					2				c	
Orthoptera: Acridoidea									b	1
Orthoptera: *Xyleus* sp.										1
Orthoptera: Grylloidea			2						c	3
Orthoptera: Tettigoniidae										1
Orthoptera: Tettigoniidae, Copiphorini					1					
Orthoptera: Ensifera			4		2		3			2
Insecta (unidentified)			2		10		4		d,e	12
Pterygota (unidentified)					5		3			
Myriapoda			1							1?
Arthropoda (unidentified)			3		2		1			6
Oligochaeta							1			
Larvae			3		1				c**	12
Reptilia: Sauria									e	
Sauria: *Kentropyx* aff. *paulensis*							1			
Sauria: *Cercosaura schreibersii*										2
Unidentified food items			24		82		15			9

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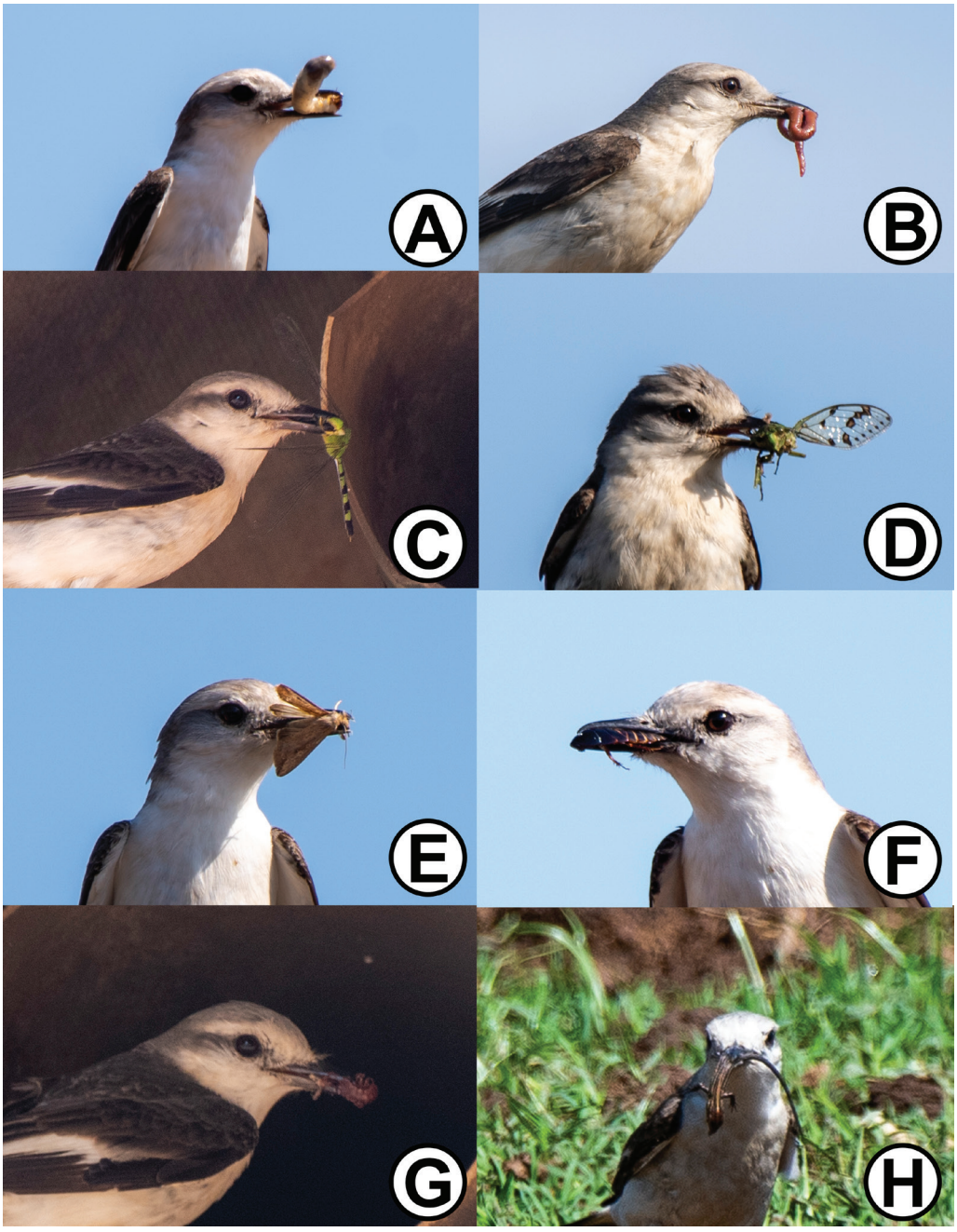

Figure 3. Food delivered to nestlings of White-rumped Monjita *Xolmis velatus*, Rio Claro, São Paulo, Brazil. A: larva, B: Oligochaeta, C: *Erythemis vesiculosa*, D: *Zammara tympanum*, E: Lepidoptera (moth), F: Blattodea, G: Myriapoda, H: *Kentropyx* aff. *paulensis* (Luiz Carlos Ramassotti)

'Rough' call. On 24 April 2021, at Serra dos Cocais (Valinhos, São Paulo, 22º56′42″S, 46º57′13″W) we observed an individual perched on a tree (3.5 m) giving a rough *preeew*. Mean duration of this vocalisation was 0.28 seconds (SD = 0.03; min. = 0.35; max. = 0.72; median = 0.28; *n* = 6), mean highest frequency 3,810 Hz (SD = 1,873; min. = 4,195; max. =

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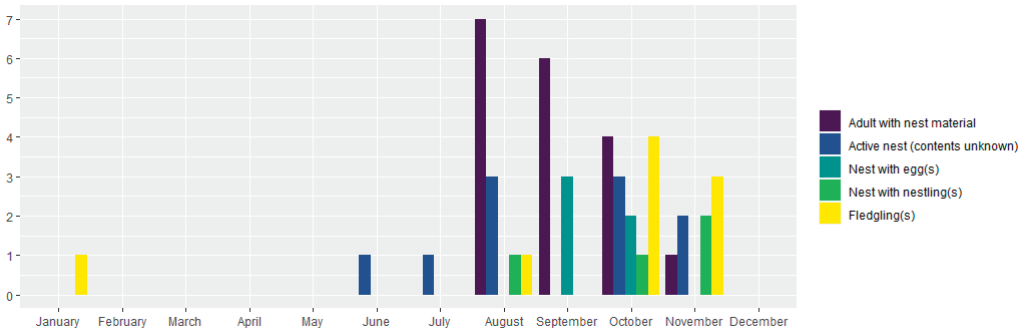

Figure 4. Seasonality in breeding records of White-rumped Monjita *Xolmis velatus* in Brazil based on citizen science data, the literature and this study.

TABLE 2
Earliest and latest records for each stage of the breeding cycle of White-rumped Monjita *Xolmis velatus*.

Stage of the breeding cycle	Earliest record	Latest record
Adult with nest material	1 Aug (WA 3908141)	5 Nov (WA 1145540)
Active nest (contents unknown)	10 Jun (WA 659766)	9 Nov (WA 1520041)
Nest with egg(s)	5 Sep (Lopes *et al.* 2013)	23 Oct (this paper)
Nest with nestling(s)	7 Aug (WA 430102)	29 Nov (WA 2385064)
Fledgling(s)	29 Aug (WA 1816888)	6 Jan (WA 4408771)

5,124; median = 4,541; n = 6) and mean lowest frequency 1,809 Hz (SD = 1,809; min. = 1,552; max. = 2,637; median = 2,238; n = 6). This call was given very intermittently, sometimes only at intervals of more than one hour. It is heard in most of the recordings available in citizen science databases (e.g., ML 235977091), which may indicate that it is frequent in the repertoire.

Aerial calls. Also on 24 April 2021, two monjitas interacted by making aerial pursuits and vocalising similar to the flight calls of Cobalt-rumped Parrotlet *Forpus xanthopterygius* (ML 329724141). The interactions were possibly not agonistic because they landed and foraged near one another, and moved together between foraging sites. Aerial calls had a mean duration of 0.1 seconds (SD = 0.03; min. = 0.05; max. = 0.13; median = 0.11; n = 1), a mean high frequency of 5,494 Hz (SD = 141; min. = 5,367; max. = 5,696; median = 5,457; n = 1) and mean low frequency of 4,107 Hz (SD = 334; min. = 3,747; max. = 4,527; median = 4,077; n = 1). A recording is available with calls similar to those described, which corroborates that they are used in contact between individuals (see comments on ML 69262581).

Begging calls. On 12 October 2021 at 06.30 h, also at Serra dos Cocais, we observed a fledgling begging from its presumed parents. It uttered a quick sequence of simple notes, in 30 seconds emitting 88 notes at a mean interval of 0.25 seconds (SD = 0.11; min. = 0.14; max. = 0.72; median = 0.21), with mean note duration 0.05 seconds (SD = 0.005; min. = 0.04; max. = 0.6; median = 0.05), mean highest frequency 7,513 Hz (SD = 528; min. = 7,016; max. = 8,730; median = 7,295) and mean lowest frequency 5,094 Hz (SD = 65; min. = 4,943; max. = 5,222; median = 5,103) (Fig. 5A; ML 377809741). This vocalisation was given by the fledgling when one of the adults approached its perch with or without food. There is only one recording of begging calls available online (ML 69262591), with vocalisations similar to those described here.

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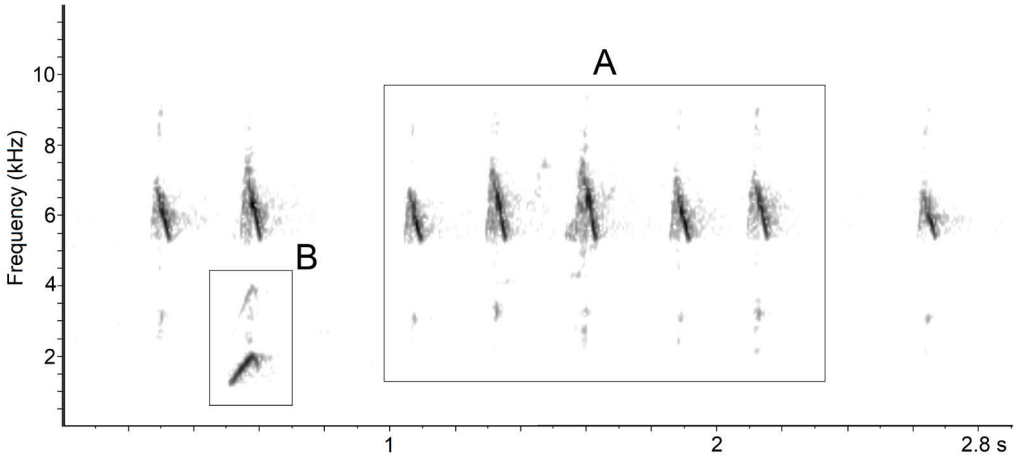

Figure 5. Begging calls of a fledgling (A) and calls of an adult (B) White-rumped Monjita *Xolmis velatus*. Sonogram made using software Raven Pro 1.6.1 (Center for Conservation Bioacoustics 2019).

Contact/Agonistic calls. Also on 12 October 2021, the putative pair used a single call (Fig. 5B) for contact, increasingly frequently when agitated (e.g., prior to agonistic interactions with a Fork-tailed Flycatcher *Tyrannus savana*). The call has a mean note duration of 0.09 seconds (SD = 0.01; min. = 0.07; max. = 0.11; median = 0.09; n = 1), mean highest frequency of 2,471 Hz (SD = 411; min. = 1,913; max. = 3,029; median = 2,671; n = 1) and mean lowest frequency of 1,104 Hz (SD = 186; min. = 837; max. = 1,275; median = 1,196; n = 1). The same call was used by adults on several occasions after feeding nestlings (nest 3) at Rio Claro, perched on the roof of the building before flying off. Similar calls are heard on a few recordings on citizen science databases (e.g., WA 3873817).

Food items.—In the online citizen science platforms, we found 67 photographs showing food items (see Table 1) including: Orthoptera (n = 13), larvae (n = 12), Coleoptera (n = 6), Araneae (n = 5), Sauria (n = 2), Lepidoptera (n = 1), cf. Myriapoda (n = 1), unidentified insects (n = 12), unidentified arthropods (n = 6) and unidentified items (n = 9).

Discussion

As reported by several previous authors, we found that White-rumped Monjita presents great plasticity in its choice of nest site. It occupies roofs (Lombardi *et al*. 2010, this paper) and many different other types of cavities, including hollows excavated by birds such as woodpeckers and parakeets (Fitzpatrick *et al*. 2004), the antechamber of Rufous-fronted Thornbird *Phacellodomus rufifrons* nests (Sick 1997), a fence post (Oniki & Willis 2003) and PVC pipe (this paper). In all cases, they took advantage of pre-existing structures, as mentioned by Fitzpatrick *et al*. (2004). Several nests were in human constructions, indicating a degree of acceptance of anthropogenic environments.

The breeding period, delimited for the first time herein, differs slightly from that recorded for its congener *X. irupero* in Argentina, which nests between August and December (de la Peña 2019).

According to the literature (Lombardi *et al*. 2010) and data collected in the present study, the nest is always sited fairly low down, between 0.3 (A. Gabriel *in litt*. 2021) and 4 m above ground (this study; A. Mendonça *in litt*. 2021), mainly in hollows in wood and termite mounds. All nests were cup types (low cup/base, high cup/base, cavity/without tunnel/low cup, and cavity/with tunnel/high cup *sensu* Simon & Pacheco 2005), and the nest material

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varies, but always contains feathers in the egg chamber lining (Lombardi *et al*. 2010, Lopes *et al*. 2013, this paper). Described nests held 2–4 all-white eggs (Oniki & Willis 2003, Lombardi *et al*. 2010, Lopes *et al*. 2013, this paper).

Concerning parental care, as de la Peña (2019) and Di Giacomo (2005) found for *X. irupero*, more than one adult White-rumped Monjita feeds the nestlings. In this study, we presented the first detailed data on this behaviour in the species, finding that nestling feeding frequency is high, reaching >30 events per hour. However, given the lack of sexual dimorphism in plumage, studies of marked individuals will be needed to determine the role of each sex in nestling provisioning and to verify if there are helpers.

The information presented here about vocalisations comprises the first detailed description of the species' repertoire. Possibly other types of vocalisations are still unknown, such as mobbing, alarm and distress calls. Sick (1997) mentioned the existence of crepuscular and nocturnal vocalisations but did not provide a detailed description.

A definition of the main song in bird species is still controversial. Some authors have considered what we term the 'rough call' to be the song of *X. velatus* (Sick 1997, Farnsworth & Langham 2020). However, song is usually longer and more complex compared to other vocal types in the repertoire (Marler & Slabbekoorn 2004), being used to attract mates and defend territory, which fact has never been objectively tested. More work is needed to document the complete repertoire and function of each vocalisation.

Prey captured by the species includes a wide variety of animals, from invertebrates (Moojen *et al*. 1941, Schubart *et al*. 1965, Gimenes *et al*. 2007, this paper) to small vertebrates like lizards (Buzzetti & Silva 2008, this paper). We recorded for the first time the phylum Annelida, arthropod subphylum Myriapoda and insect orders Blattodea, Lepidoptera and Odonata in the species' diet. The apparent preference for insects corroborates the general pattern among Tyrannidae (Winkler *et al*. 2020).

Finally, we provided the first detailed compilation of the diet of nestlings of White-rumped Monjita, which includes eight orders of insects, spiders, earthworms, myriapods, and even small lizards, showing great plasticity in prey and, consequently, adaptability to environmental disturbance, making it possible for the species to nest near humans.

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