



## REPRODUCTIVE AND AGONISTIC BEHAVIORS OF BLACK-FRONTED PIPING GUANS CANDIDATES FOR RELEASE AND REINTRODUCED (GALLIFORMES: CRACIDAE) IN THE BRAZILIAN ATLANTIC FOREST

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**Abstract:** The black-fronted piping guan, *Pipile jacutinga*, is an endemic Atlantic Forest cracid currently classified as Endangered in Brazil and globally. We present data on the reproductive and agonistic behaviors of a pair of captive reared Black-fronted piping guans reintroduced in a protected area in Serra da Mantiqueira, São Paulo state, Brazil, as well as opportunistic records of reproductive behavior of Black-fronted piping guan candidates for release that were held inside a pre-release acclimation enclosure. Behavioral data were collected from September 2017 to February 2018. We conducted 172 h of observations across 97 days of monitoring. Six reproductive behaviors were recorded: 1) Wing Display, 2) Nodding Call, 3) Mating Dance, 4) Male Offering Food to Female, 5) Tail Fanning and 6) Copulation. Two white eggs were seen on the 14<sup>th</sup> day of incubation in a natural nest built in a tree fern. Only the female was observed incubating the eggs. The female devoted over 90 % of her time to incubation, the rest mainly to foraging or vigilance. The male spent 48 % of time vigilant nearby of the nest but did not interact with the female or eggs. On the 20<sup>th</sup> day, incubation was interrupted following heavy rain. Agonistic interactions related to territory defense were observed between the released male and males inside the pre-release acclimation enclosure. On 88 % of the occasions we observed territorial defense behavior between the reintroduced male and other males inside the enclosure. The observations of the pair of reintroduced Black-fronted piping guans and of the candidates for release, provided valuable information about the reproductive behaviors of this largely unstudied and critically threatened species.

**Keywords:** monitoring; reintroduction; reproductive biology; territory; threatened.

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## INTRODUCTION

The monitoring of reintroduced animals is necessary to evaluate release techniques and to assess if captive-bred animals maintain species-typical behavior, especially reproductive behaviors—one of the main indicators of a self-sustaining reintroduced population (Sarrazin & Barbault 1996, Caro 1999, Armstrong & Seddon 2008, McPhee & Carlstead 2010, Sutherland *et al.* 2010). Also, monitoring can provide behavioral data for species for which information is scarce, as is the case for most threatened species (Tweed *et al.* 2003). A case in point is the Black-fronted piping guan, *Pipile jacutinga* (Spix, 1825) (Galliformes, Cracidae), a Neotropical species with a poorly known natural history. This great cracid (63.5–74 cm; 1100–1600 g; Sigrist 2009) is endemic to the Atlantic Forest, its original distribution extends from southern Bahia State, Brazil to Argentina (Misiones Province) and Paraguay (Departments Alto Parana and Canindeyu). This species is currently classified as Endangered in Brazil (ICMBio 2018) and globally (BirdLife International 2019), due to illegal hunting and habitat loss. The main remaining populations are found in protected areas in the Brazilian states of São Paulo and Paraná, and in Argentina (Silveira *et al.* 2008, del Hoyo *et al.* 2014).

Black-fronted piping guans are frugivorous and play an important ecological role as seed dispersers, contributing to the maintenance and regeneration of forests (Galetti *et al.* 1997). They are found in mature primary forests and, less frequently, in secondary forests at different stages of regeneration (Galetti *et al.* 1997, Guix 1997). The species mainly inhabits the forest canopy, occasionally descending to the forest floor to feed or drink water. It is easier to observe individuals in strips of forests close to water bodies. Black-fronted piping guans have also been observed in tall *restinga* forest and once in a *Pinus* sp. plantation (del Hoyo *et al.* 2014).

A reintroduction strategy has been adopted for the conservation of this species in which new populations are being established and low-density populations reinforced. Reintroduction of captive-born birds is afforded by the large number of birds present across a number of captive facilities (Silveira *et al.* 2008). One obstacle to a successful reintroduction project is the scarcity of published data about the ecology and biology of captive or wild

Black-fronted piping guans (Schubart *et al.* 1965, Cominese-Filho *et al.* 1986, Paccagnella *et al.* 1994, Galetti *et al.* 1997, Sick 2001, Bernardo *et al.* 2011). One of the four previous attempts to reintroduce captive-born Black-fronted piping guans in Brazil had moderate short-term success based on the number of chicks born in the wild recorded during post-release monitoring (RPPN Fazenda Macedônia, CENIBRA 2017). The absence of long-term monitoring had hindered the assessment of success or failure in other reintroduction projects (Brooks & Strahl 2000, Silveira *et al.* 2008, del Hoyo *et al.* 2014, ICMBio 2018, SAVE Brasil 2019).

Here we present data on the reproductive and agonistic behaviors of Black-fronted piping guans living either in an *in situ* acclimation enclosure or reintroduced to the Atlantic Forest of Serra da Mantiqueira, São Paulo, Brazil. Our objective is to describe the behavioral repertoire related to reproduction, including display behavior, territorial defense, mating, nesting and incubation from (1) systematic data on the reproduction of a reintroduced male-female pair released in the wild and on the agonistic interaction between the released male and other males inside the pre-release acclimation enclosure, and (2) casual records of the reproduction of Black-fronted piping guans candidates for release that were inside the pre-release acclimation enclosure.

## MATERIAL AND METHODS

### *Study area*

The study was conducted in a protected private property within the Atlantic Forest of Serra da Mantiqueira, São Paulo, Brazil. The area is part of the Environmental Protection Area São Francisco Xavier (APA-SFX) (Assembleia Legislativa do Estado de São Paulo 2002) (22.9122°S, 45.9596°W, WGS 84). The APA-SFX is composed of a series of protected areas that together constitute the Mantiqueira Mosaic (Ministério do Meio Ambiente 2006). The APA-SFX covers 11.880 ha with altitudes ranging from 720 to 2082 m. The vegetation types vary among dense ombrophylous forest, altitude fields and secondary succession forests (*capoeiras*, *capoeirões*) (Assembleia Legislativa do Estado de São Paulo 2002). The average annual temperature is 21.3 °C. The climate is of the humid Cwa mesothermal type (according to the Köppen

classification) with the dry season in winter and the rainy season in summer. The region has high levels of rainfall with average annual precipitation 1303.9 mm (CEPAGRI 2015 *apud* Gonçalves 2016).

### **Animals and data collection**

Two groups of adult captive-born Black-fronted piping guans were released, group 1 (N = 9 individuals) in June 2016 and group 2 (N = 2 individuals) in July 2017 (Table 1), in an area of dense ombrophilous forest at about 900 m elevation. The birds were individually identified by a unique combination of color bands and a metal band provided by the Centro Nacional de Pesquisa para a Conservação das Aves Silvestres (CEMAVE). Of these birds, a male and a female that paired after release were monitored and their behaviors recorded. The male (age 5 yrs 7 mo) was reintroduced without transmitter in June 2016 and the female (age 2 yrs 7 mo) was reintroduced in July 2017 with a VHF transmitter (Sirtrack© model: V2H 163A).

The monitoring in the field was carried out by one or two observers who were always dressed in a brown cap, black shirt and pants with camouflage colors (green, brown or black). Observers maintained a minimum distance of five to six meters from the bird. For data collection, we used binoculars, cameras, GPS, clipboard and a tablet.

We observed the reintroduced pair and their interactions with conspecifics that were inside the pre-release acclimation enclosure (group 3, N = 9 individuals) during the reproductive season

from September 2017 to February 2018. We also recorded observations on the reproductive biology of individuals inside the enclosure. Two artificial basket-shaped nests made of plant material (60 cm diameter) were placed near the pre-release acclimation enclosure in the top layer of the canopy forest (one nest at 7 m height and another at 10 m height), the forest stratum most used by this species (Paccagnella *et al.* 1994, Galetti *et al.* 1997, del Hoyo *et al.* 2014)

Field observations were conducted between 06:00 h and 17:00 h. Behavioral data of the reintroduced pair were collected through focal animal sampling sessions of 60 minutes (Altmann 1974). Each session was divided into twelve 5 min intervals. During these intervals, reproductive behaviors (events) were collected using all occurrences sampling and behavioral data (states) using one-zero sampling (Altmann 1974). Behavioral data from birds inside the pre-release acclimation enclosure were collected through *ad libitum* sampling (Altmann 1974). The behaviors recorded were: Foraging (FOR): Included eating, drinking or inspecting food items and moving around within a food source searching for items, Interaction: All social interactions, Incubation: Sitting over the eggs. While incubating the bird could engage in other activities such as maintenance of feathers, rest, vigilance, foraging or even nest maintenance. In those cases, we indicate the behavior with /inc., Maintenance: preening of feathers, scratching the head with his foot, cleaning the beak on the branch, gaping, Nest Maintenance:

**Table 1.** Black-fronted piping guans reintroduced at the Environmental Protection Area of the São Francisco Xavier, São Paulo.

<b>ID Bird</b>	<b>Release date</b>	<b>Sex</b>	<b>Transmitter type</b>	<b>Monitored in this study</b>
1	Jun/2016	F	ARGOS	
2	Jun/2016	M	ARGOS	
3	Jun/2016	F	ARGOS	
4	Jun/2016	F	No transmitter	
5	Jun/2016	F	No transmitter	
6	Jun/2016	M	No transmitter	X
7	Jun/2016	M	No transmitter	
8	Jun/2016	M	No transmitter	
9	Jun/2016	M	ARGOS	
10	Jul/2017	F	VHF	X
11	Aug/2017	F	VHF	

Removing waste or debris from the nest, pecking or preening the nest material. Could be done while the female incubated, Resting: Assuming a posture of laying on its legs; eyes closed or partially closed, neck retracted or under wing, Vigilance: visually searching the environment, either looking above or below the animal's position, sitting or standing, Locomotion: moving around the environment (walking or flying) from one location to another, and Vocalization: Emitting any kind of vocalization.

### **Data analyses**

The data were expressed either as total counts per 60 min focal session or as percentage of the number of 5 min intervals in which the behavior occurred. The analyzes were performed on the total number of records of each behavior (frequency) by the male and the female of the pair. The data were analyzed using contingency table analysis ( $\chi^2$  for > 2 with 5000 Monte Carlo simulations, see Zar 2013). Because incubation constraints other behaviors and because it is mostly a female behavior, we also compared male and female behavioral frequencies without incubation. In this case all behaviors labelled \*/inc were assigned to incubation and removed from analyses. All tests were calculated with XLSTAT® (XLSTAT 2013), with two-tailed probabilities and  $\alpha = 0.05$ .

## **RESULTS**

Black-fronted piping guans were observed for 172 h during 181 focal periods (Female N = 85, Male N = 96) across 97 days of monitoring. Seven focal periods with < 30 min of observation due to the loss of visual contact with released individuals were not considered for analyses. Observations were more frequently conducted in the morning (between 06:00 h and 12:00 h; N = 133 focal periods) than in the afternoon (between 13:00 h and 17:00 h; N = 48 focal periods). The released pair was usually observed near the pre-release acclimation enclosure.

### **Description of the behavioral repertoire**

We recorded six behaviors related to reproduction: 1) Wing Display (N = 38), 2) Nodding Call (N = 69), 3) Mating Dance (N = 42), 4) Male Offering Food to Female (N = 2) and 5) Tail Fanning (N = 1) and 6) Copulation. (N = 1). Except to Wind Display and

Copulation behaviors, all the other were described for the first time for Black-fronted piping guans. Only the male performed the Wing Display, Mating Dance and Male Offering Food to Female. Only the female exhibited Tail Fanning.

The Wing Display was recorded from August to November 2017 and in February 2018. The Wing Display consisted of a combination of a call while the bird was perched followed by an in-flight display. First, the male, perched alone, on or near the forest canopy, emits a vocalization characterized by a prolonged sequence of loud whistles with ascending amplitude toward the end. This vocalization is similar to the “üi, i, i, i, i, i” vocalization of the Grey-hooded Attila *Attila rufus* (Vieillot, 1819) (Passeriformes, Tyrannidae), a bird also present in the Atlantic Forest, but the Grey-hooded Attila call lacks the upward amplitude shift toward the end. After vocalizing, the male performed the Wing Display, by taking flight from the perch and producing a mechanical sound with the wings during a prolonged slow flight toward the canopy of a nearby tree.

The Nodding Call consisted of moving the head up and down, as if the reintroduced male was shaking the head in agreement with something (like a “yes”), while vocalizing a low and continuous hum (“fui fui fui”), and on some occasions, walking over the substrate (i.e. ground, tree branch and in the center of the canopy of a tree fern). This behavior was observed predominantly on the tree canopy and was associated with copulation attempts. The female approached the male after this behavior. A similar behavior was displayed by the female, but without vocalization. On four other occasions, the female was observed performing only the vertical nodding movement with the head. One of these occurred during an interaction with the reintroduced male. The male and female interacted during the performance of this behavior. While the male performed the Nodding Call and the Mating Dance in the center of a tree fern canopy, the female flew to meet the male and perched beside it. Both continued to make nodding movements facing each other. The female subtly pecked at the male's tail, then the male gave his perch to the female, who perched in the center of the fern's crown while the male perched beside her on a leaf. The female continued to nod repeatedly as she took leaves from the male's beak. Apparently, the presence of

the observers disturbed the female who rose from the center of the tree fern, walked over and perched in the foliage of the fern, while the male remained in the same place. Both continued to nod repeatedly towards each other. The entire interaction was recorded throughout a single observation session (60 min). On the other three occasions, it was not possible to determine the context (cause or stimulus) of this behavior.

The Mating Dance was usually recorded after the Nodding Call behavior and often incorporated this call into it. This behavior was recorded on September, November, December 2017 and January 2018. The reintroduced male, while making the Nodding Call, would peck at leaves and twigs. Occasionally, he would move around the substrate (i.e. ground, tree branch and in the center of the canopy of a tree fern) placing leaves or twigs on the trunk or under his body when it was perched. When perched, the male continued to make nodding movements and gather more material to place under his body. This behavior was mostly observed in the canopy (88 %, N = 37), especially in vines, or under the canopy of tree ferns and while on thick branches.

The Male Offering Food to female was recorded on November, 2017 and January, 2018. The male was perched on a pod of fruits of the *juçara* palm *Euterpe edulis* Mart. (Arecales, Arecaceae) and started to display the Nodding Call while carrying one of the fruits in the beak. The female approached the male and took the food directly from his beak. On another occasion the individuals were close to each other on the forest ground. The male picked up from the ground a fruit from *Alchornea sidifolia* Müll.Arg. (Malpighiales, Euphorbiaceae), began the Nodding Call, and approached the female, who took the fruit directly from his beak.

Tail Fanning, a behavior performed exclusively by the female, was recorded once (September 2017). This behavior was characterized by head movement similar to that of the Nodding Call while lifting and spreading the tail. On the first day that individuals were seen close to each other outside the pre-release acclimation enclosure, the male and female were spotted on the same tree. The female, which was perched on a lower branch, oriented her head a few times towards the male while performing nodding movements. Then she slashed at a few leaves with her beak while looking up

toward the male. Next, she repositioned herself on the branch with the back turned toward the male, leaned forward and lifted the tail while spreading its feathers (as if fanning).

Tail Fanning behavior was also displayed by one of the female candidates for release that was inside the pre-release acclimation enclosure. She tilted her body forward while lifting and opening her fan-shaped tail with her legs slightly bent and stomped on the substrate while alternately nodding and emitting a slightly audible vocalization. This behavior was observed on the ground and upper stratum and often in the presence of one male.

Two copulation attempts were recorded between male and female. Copulation attempts were characterized by the male, with wings partially extended, chasing the female to corner her on a substrate (i.e. ground and on the pre-released acclimation enclosure); the Nodding Call and the Wing Display were performed but with no apparent sequence. On the other hand, copulations were observed among candidates for release that were inside the pre-release acclimation enclosure. As described before, the male with its wings lowered chased the female on the ground when it reached the female, climbed on the back of the female who laid her chest down to the ground. The male, with wings spread, pecked the nape of the female and positioned his cloaca in contact with her cloaca.

#### ***Nesting, Incubation and Concomitant behavior of a pair released to the wild***

Artificial nests were not used by reintroduced Black-fronted piping guans. The natural nest was built in the center of the canopy of a fern tree *Cyathea delgadii* Sternb. (Cyatheales, Cyatheaceae) with 6 m height, diameter of 14.3 cm and a canopy area of 16.2 m<sup>2</sup>. The fern was located at an altitude of 900 m on the edge of a trail used by visitors or reserve staffs, and 40 m from the pre-release acclimation enclosure, 40 m from a stream and 41 m from a pasture area. The nest was placed in the depression formed where leaves radiate from the center of canopy of tree fern (Figure 1). The female improved the nest with plant material from the tree itself even after the beginning of the incubation period.

The female was observed resting in the incubation position in February 1, 2018 (Figure 1). However, the eggs were not seen. From this date,



**Figure 1.** Reintroduced female of Black-fronted piping guan seated in the nest built in the center of a fern tree canopy in the Atlantic forest of southeastern Brazil.

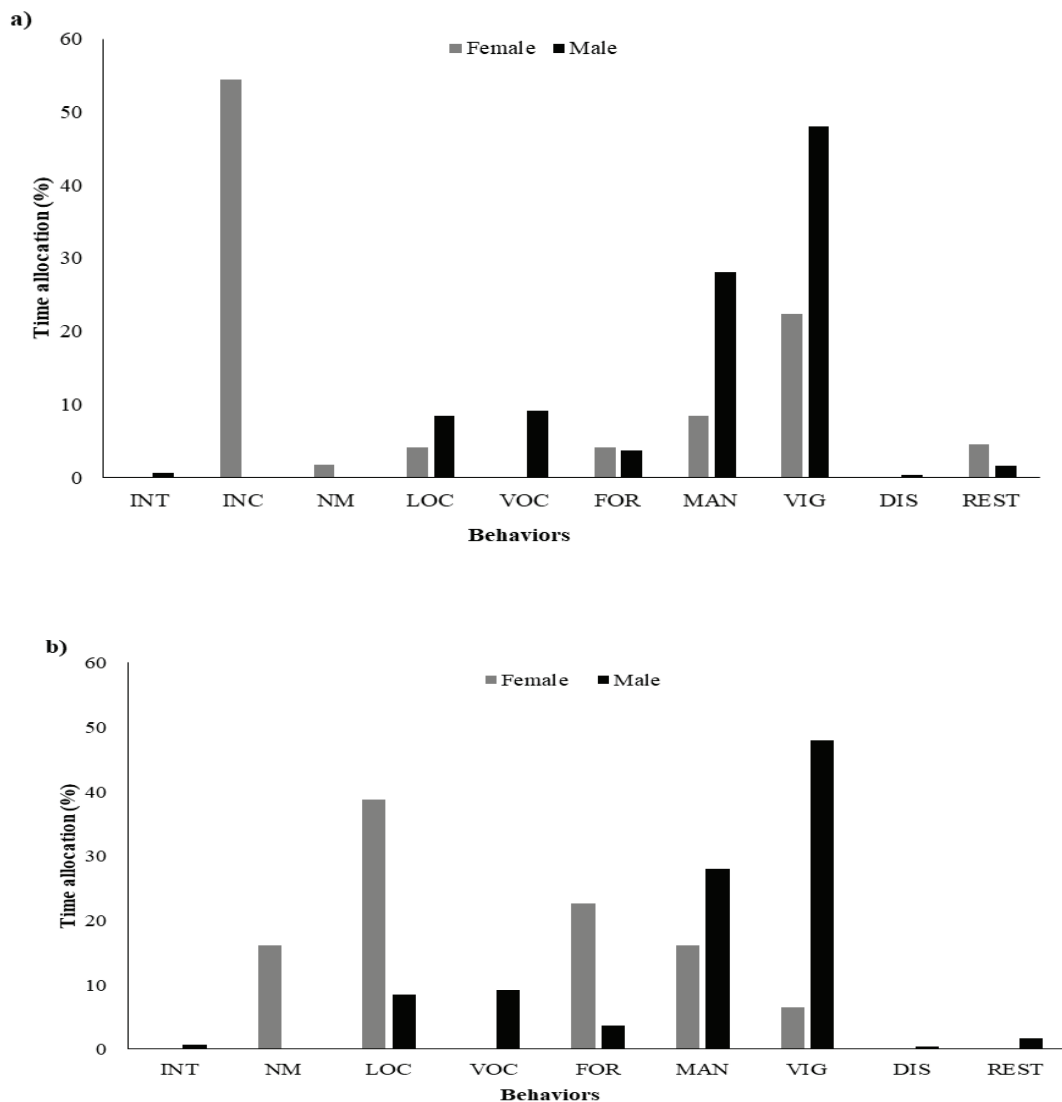
25 focal periods were carried out (Female:  $N = 15$ , Male:  $N = 10$ ). Only the female was observed incubating the eggs. The male and the female differed in the time allocation to the different behaviors recorded (Figure 2a;  $\chi^2 = 261.91$ ;  $df = 9$ ;  $p < 0.0001$ ). Significant differences between the male and female were also obtained when we removed from the analysis both incubation (Figure 2b;  $\chi^2 = 104.73$ ;  $df = 8$ ;  $p < 0.0001$ ) and vigilance ( $\chi^2 = 48.21$ ;  $df = 7$ ;  $p < 0.0001$ ). While incubating, the three most common behaviors of the female were Sitting (54.4 %), Vigilance (21.8 %) and Maintenance (6.7 %). During the incubation period, the male did not exhibit parental care behavior nor interacted with the female. He was often seen in the vicinity of the pre-release acclimation enclosure, away from the nest.

The female was sighted off the nest three times: On 15 February 2018, when heavy rain occurred, it remained off the nest for at least 15 min; On 16 February 2018 she remained off the nest for about 30 min, foraging on the fruits of *A. sidifolia*; On 19 February 2018 she was observed off the nest for about 55 min while preening, after it had rained

the day before. At 08:05 h returned to the nest and resumed incubation, and at 08:25 h again left to forage on *A. sidifolia* fruits. At no time did the male replace the female in the nest while she was away. We recorded the female foraging (12 events: 2.7 %), and on seven occasions she fed on the leaves of the tree fern while incubating the eggs.

Two white eggs were sighted in the nest 14 days after the start of incubation (Figure 3). We avoided approaching the nest and manipulating the eggs. The incubation period was interrupted between the 19<sup>th</sup> and 20<sup>th</sup> day, a period with heavy rainfall. During those days, the female was observed to leave the nest for periods of time to dry the feathers and forage. On the 20<sup>th</sup> day the female was not in the nest and fragments of eggs were found under the arborescent fern. The eggs are presumed to have fallen from the nest after heavy rain.

Other social interactions were observed during the reproductive season ( $N = 195$  events) between the released pair and the Black-fronted piping guan candidates for release ( $N = 9$  individuals) that were inside the pre-release acclimation enclosure. The reintroduced male interacted



**Figure 2.** Time allocation (in percentage) to all behavioral categories observed for the pair of Black-fronted piping guans (a) and while the female was incubating the eggs - all behaviors that had \*/inc were removed from the analysis (b), in the Atlantic forest of southeastern Brazil (INT – Interaction; INC – Incubation; NM – Nest Maintenance; LOC – Locomotion; VOC – Vocalization; FOR – Foraging; MAN – Maintenance; VIG – Vigilance; DIS – Display; REST – Resting).

with the males inside the pre-release acclimation enclosure, mainly with an apparently dominant male (80 %, N = 156 events). On 88 % of the events we observed a behavior of territorial defense between the reintroduced (approx. 7 yrs old) male and a male inside the enclosure (approx. 8 yrs old). The two males stood facing each other, their crests raised, and vocalized intermittently while making a horizontal movement with their heads from side to side, like a “no” (N = 59). On other events (N = 111), one of the males (both the reintroduced and candidates for release) chased the other near the enclosure railing and with the crest raised and

vocalizing, pecked the other individual through the railing.

Males also emitted the “píoóóóó” call, a territorial vocalization with a loud beginning and softer ending, during a descent-rise tail display. This vocalization was emitted when the male faced another male, whether perched on a branch or on the ground. Sometimes the male would inflate his chest and flap his wings. This vocalization was also performed by the reintroduced male when perched in tall trees around the pre-release acclimation enclosure, both in the presence and absence of the female.



**Figure 3.** Nest of Black-fronted piping guan with two eggs (only one egg circled in red) found in the Atlantic forest of southeastern Brazil.

## DISCUSSION

The observations of the pair of reintroduced Black-fronted piping guan and those of the candidate birds for release provided valuable information about the reproductive behaviors of this Critically Endangered species. The present observations describe various reproductive and agonistic behaviors of the Black-fronted piping guans: display behaviors, complete mating, nesting and some incubating behaviors. Our study describes some reproductive behaviors displayed in sequence that have not been previously described for this Neotropical cracid: Nodding Call, Mating Dance, Tail Fanning and Male Offering Food to Female. The study also enhanced the ethogram for copulation behavior, the description of the nest and behavior of both sexes during incubation.

Although the breeding attempt was unsuccessful, some of the reproductive behaviors exhibited by the pair of reintroduced Black-fronted piping guans, such as the Wing Display, platform-nesting, and the preference for upper forest

stratum, match previously published descriptions of native wild birds (Paccagnella *et al.* 1994, Galetti *et al.* 1997, del Hoyo *et al.* 2014). This suggests that captive rearing has not led to the loss of species-typical reproductive behaviors.

### *Description of the behavioral repertoire*

The reproductive season observed in the present study coincided with that recorded in other places where the Black-fronted piping guan occurs (Galetti *et al.* 1997, Sick 2001, del Hoyo *et al.* 2014). In the wild, Wing Display is thought to indicate the beginning of the reproductive season (Sick 2001). In the present study, this behavior was first observed in August, coinciding with the beginning month of this behavior in the southeast of Brazil (del Hoyo *et al.* 2014). Sick (2001) described that the sound produced by the wings of the Black-fronted piping guan as resembling a “tearing” of a thick cloth or the noise produced by a large tree falling. Black-fronted piping guan nests with chicks have been sighted from October to February (del Hoyo *et al.* 2014). This period would coincide with the



hatching of eggs from the pair of the reintroduced Black-fronted piping guans had they succeeded in reproducing.

We recorded four other behaviors related to reproduction: 1) Nodding Call, 2) Mating Dance, 3) Male Offering Food to Female and 4) Tail Fanning. In a previous study on captive breeding of Black-fronted piping guans, none of these four reproductive behaviors were described: Cominese-Filho *et al.* (1986) only reported that the male becomes more “attentive” toward the female and emits long peeps during the reproductive season.

Birds of the order Galliformes have an extensive repertoire of reproductive display behaviors (see Neves 1988, Garcia & Brooks 1997, Mateos 1998). The reproductive behaviors of *P. jacutinga* appear to be similar to those of other closely related species cracids (Sick 2001, Aguilar & Aguilar 2012, del Hoyo *et al.* 2014). Neves (1988) observed male courtship behaviors of captive Dusky-legged Guans *Penelope obscura bronzina* Hellmayr, 1914 that are similar to those we observed.

The copulation behavior observed inside the enclosure is similar to that described for another species of cracid, the Speckled Chachalaca *Ortalis guttata* (von Spix, 1825) (Dantas & Silva 2003). Previous studies of captive Black-fronted piping guans studies (Cominese-Filho *et al.* 1986) did not report the copulation behavior, however they describe that moments before copulation when the male becomes more aggressive toward the female, forcing her to yield. This aggressiveness of the male is usually in the form of strong pecking and biting of the female’s neck.

#### ***Nesting, Incubation and Concomitant behavior of a pair released to the wild***

The nest was constructed in a well-preserved forest, with food resources such as *juçara* palms, the main food resource of the Black-fronted piping guans in sympatric zones (Galetti *et al.* 1997). The nest was also located near a water body, which is a habitat usually associated with the genera *Aburria* and *Pipile* (Paccagnella *et al.* 1994, Galetti *et al.* 1997, del Hoyo *et al.* 2014). This species constructs simple platform nests with branches and stems in forks of trees, vine tangles, on rocks and even on the ground (Galetti *et al.* 1997, Sick 2001, del Hoyo *et al.* 2014). Active nests have been recorded at 1.7 m from the ground on a shrub for Black-fronted piping guan

(Galetti *et al.* 1997) and a coffee *Coffea* sp. stand 2.5 m from the ground for the Trinidad Piping-guan *Pipile pipile* (von Jacquin, 1784) (Pawi Study Group 2019). In the present study, the female selected a shallow depression formed by radiating leaves of a fern at 6 m from the ground.

The construction of the nest of Black-fronted piping guans is mainly carried out by the female (del Hoyo *et al.* 2014). Males do not participate, differing from other congeners and the Wattled guan *Aburria aburri* (Lesson, 1828) (Aguilar & Aguilar 2012). Captive female Black-fronted piping guans were frequently observed in the nest prior to laying, standing for long periods on the nest straw, often adjusting it (Cominese-Filho *et al.* 1986). We did not observe the construction of the nest, only its enhancement by the female with plant material collected from the surroundings. The male did not seem to participate in nest tending, although in the days prior to egg laying, he was observed in the fern canopy performing the Nodding Call and the Mating Dance, sometimes placing leaf material under his body.

The behaviors of male and female differed during incubation. The female spent 90 % of her time incubating, mostly just sitting on the eggs, but when not, she was vigilant. The male did not incubate but did allocate a significant amount of time to vigilance behavior in the area surrounding the incubating female. When time allocation is analyzed excluding incubation, there was still a significant difference between male and female time budgets. Females foraged or moved among feeding trees, whereas males were vigilant or doing feather maintenance. These observations suggest that incubation constraints time allocation to other behaviors, especially social. When the female leaves the nest, it is to forage, to move (presumably among feeding sources) or to dry feathers after a rain. The female rarely left the vicinity of the nest with eggs. Nests are usually constructed near feeding sources.

In captivity, Black-fronted piping guan females lay from two to four eggs which are incubated by the female for 28-30 days (Cominese-Filho *et al.* 1986, del Hoyo *et al.* 2014). Incubation is carried out almost exclusively by the female and is only replaced by the male when she feeds (Cominese-Filho *et al.* 1986). The females begin to incubate the eggs immediately after the laying of the third and last egg (C. R. Ruiz-Miranda, personal

communication). We observed two eggs 14 days after the female was frequently observed in the nest. It is possible that the eggs may have been laid before this first sighting but could not be seen because they were concealed by foliage. Even though the female incubated the eggs for long periods of time, the male was not observed exhibiting any caring behavior toward her (i.e., feeding) or the eggs (incubating when the female left to forage).

There is no published information about the social behaviors, including pair bonding or territory defense for this species. Alexander (2002) and Hayes *et al.* (2009) described an agonistic interaction between males of the Trinidad piping-guan, in which males perform raised their crest feathers, similar to the behavior observed in the present study.

The observed Black-fronted piping guans exhibited species-specific behaviors during the reproductive period. The attempted breeding observed was not successful because the eggs did not hatch, possibly due to adverse climatic conditions (heavy and constant rainfall). This is an expected stochastic event also acting on native wild Black-fronted piping guan populations. Reintroduction plans must consider these effects of stochastic events when estimating the number of pairs to release so as to increase the chances of successful reproductions.

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