

Predation of the Buffy-fronted Seedeater *Sporophila frontalis* (Aves: Emberizidae) on *Merostachys neesii* (Poaceae: Babusoideae) seeds during a masting event in the Atlantic forest

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Abstract: The Buffy-fronted Seedeater *Sporophila frontalis* (Verreaux, 1869) is frequently found foraging on seeds during ephemeral masting events of bamboos in the Atlantic forest. In the present study, we analyzed the predation activity of *S. frontalis* on seeds of *Merostachys neesii* Rupr. during a masting event in an Atlantic forest reserve on southeastern Brazil. We conducted point counts in spots with *M. neesii* and in spots without bamboos along trails to determine the presence of *S. frontalis* on *M. neesii* clumps. Additionally, focal observations on bamboo clumps and seed traps were used to verify the predatory impact of *S. frontalis* on *M. neesii* seeds. *S. frontalis* was present in 6 out of 18 point counts in *M. neesii* clumps. The seedeater behaved territorially in bamboo clumps and presented a mean predation rate of 1.10 bamboo seeds/minute. Seed traps had up to 80% of the seeds predated. The large amount of seeds available during bamboo masting events probably contributes to the maintenance of wandering populations of *S. frontalis* in the Atlantic forest. On the other hand, the predation of seeds by *S. frontalis* may reduce the reproductive germination and the propagation of the bamboos whose growth may in turn negatively affect the establishment of other forest species.

Keywords: bamboos, bird-plant interaction, Emberizidae, foraging behavior, predation rate.

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Resumo: O pixoxó *Sporophila frontalis* (Verreaux, 1869) é frequentemente encontrado forrageando em sementes durante eventos de frutificação em massa de bambus na floresta Atlântica. No presente estudo, nós analisamos a atividade de predação de *S. frontalis* em sementes de *Merostachys neesii* Rupr. durante um evento de frutificação em uma reserva da floresta Atlântica no sudeste do Brasil. Nós conduzimos pontos de contagem em locais com *M. neesii* e em locais sem bambus ao longo de trilhas para determinar a presença de *S. frontalis* em touceiras de *M. neesii*. Adicionalmente, observações focais e coletores de sementes foram utilizados em touceiras de *M. neesii* para verificar o impacto de predação em sementes realizado pelo pássaro. *Sporophila frontalis* esteve presente em 6 de 18 pontos de contagem com touceiras de *M. neesii*. Esta espécie se comportou territorialmente em touceiras de bambu e apresentou uma taxa de predação média de 1.10 sementes/minuto. Os coletores de sementes possuíram até 80% das sementes predadas. Provavelmente, a enorme quantidade de sementes disponíveis durante eventos de frutificação em massa de bambus contribuem para a manutenção de populações vagantes de *S. frontalis* na floresta Atlântica. Por outro lado, a predação de sementes por *S. frontalis* pode reduzir a germinação reprodutiva e a propagação de bambus, cujo crescimento interfere negativamente no estabelecimento de outras espécies de plantas arbóreas.

Palavras-chave: bambus, interação ave-planta, Emberizidae, comportamento de forrageio, taxa de predação.

Introduction

The bamboos are perennial evergreen plants in the tropics belonging to the true grass family (Poaceae). In the Neotropical region, the highest diversity of bamboos occurs in Brazil (18 genera and 155 species, 129 being endemic) (Filgueiras & Gonçalves 2004). The Brazilian Atlantic forest is particularly rich in bamboos and some regions have more than 30 species (Judziewicz et al. 1999). The semelparity as a reproductive strategy of these plants has a strong potential to attract seed predators due the huge crop of seeds available during masting events occurring at intervals of 3 to 120 years after which plants die (Numata 1974, Janzen 1976, Campbell 1985).

The competition between bamboo relatives, the climate periodicity and the seed consumer satiation are some potential evolutionary influences that may explain the bamboos mast-seeding events (Janzen 1976, Campbell 1985). In the latter, some birds act as predators and may be ecologically benefited by the enormous availability of seeds. Several bird species are already pointed as associated with bamboos in the Neotropical region (Stotz et al. 1996). Additionally, the increments of bird populations during bamboo fruiting events are widely reported in the literature (Davis 1945, Collar et al. 1992, Olmos 1996, Sick 1997, Vasconcelos et al. 2005, Areta et al. 2009).

An uncontrolled population of bamboo may inhibit the establishment of other arboreal plant species by processes of nutrients competition, obstruction of light and seeds limitation (Smith et al. 1981, Oliveira-Filho et al. 1994, Rother et al. 2009). In this context, seed-predators like birds might contribute to control bamboo populations by limiting successful seedling. In the Atlantic forest, some species of emberizids, e.g., *Haplospiza unicolor* Cabanis, 1851, *Sporophila falcirostris* (Temminck, 1820), *S. frontalis* (Verreaux, 1869), *S. schistacea* (Lawrence, 1862), and *Tiaris fuliginosus* (Wied, 1830) are the most observed birds during flowering and fruiting events of several bamboo species, including *Chusquea* spp., *Guadua* spp., *Merostachys* spp., and *Parodiolyra* spp. (Collar et al. 1992, Olmos 1996, Vasconcelos 2002, Vasconcelos et al. 2005, Sick 1997, Sigrist 2006, Areta & Bodrati 2008, Areta et al. 2009).

Sporophila frontalis is frequently cited as associated with *Merostachys* bamboos in Brazil (Vasconcelos 2002, Sick 1997, Sigrist 2006). However, no study has analyzed in details this association. In the present study, we document the feeding association of *S. frontalis* on *M. neesii* in a masting event occurred in the Atlantic forest in southeastern Brazil. We suppose that the bird predatory activity on seeds partially mediates the bamboo population control in the studied area.

Material and Methods

1. Study area

This study was conducted in Ribeirão Grande (24° 15' 27,6" S and 48° 24' 07,5" W) at Fazenda Interales State Park, located on the Serra de Paranapiacaba, São Paulo state, southeastern Brazil. Great part of the 490 km² of Fazenda Interales is formed by a continuous of Atlantic forest vegetation with altitudinal range between 60 and 1.100 m (Fundação Florestal 2010). Climate in the upper relief (nearly 850 m) of the studied region is cool and wet, with average precipitation of 1.600 mm per year (see Olmos (1996) for more information).

2. Target species

Sporophila frontalis is a nomad, rare to uncommon species at forest borders and in regenerating clearings (Ridgely & Tudor 1994,

Sick 1997). It is considered vulnerable (Birdlife International 2008) and endemic to Atlantic forest (Collar et al. 1992). It is notably arboreal for a seedeater, and it can be briefly more numerous in events of bamboo flowering and masting mainly on mountains of southeastern Brazil (Ridgely & Tudor 1994, Sick 1997). Population estimates range from 2.500 to 10.000 individuals (Birdlife International 2008). The geographic distribution of this species extends from extreme southern Espírito Santo and south-east Minas Gerais states south through Rio de Janeiro (bulk of individuals) to Rio Grande do Sul in Brazil, eastern Paraguay and Misiones in Argentina (Collar et al. 1992, Birdlife International 2008). According to Birdlife International (2008), the population of *S. frontalis* has been greatly reduced since the late 19th century and its patchily distributed populations experience illegal pet trade and continuing clearance of Atlantic forest. In the studied region, *S. frontalis* is rarely seen, except in bamboo flowering and fruiting periods (pers. comm., staffs of Fazenda Interales State Park).

The bamboo genus *Merostachys* includes 53 species, and its geographic distribution ranges from Central America, south to Argentina. Brazil is considered the center of diversity of *Merostachys* spp. (Soderstrom et al. 1988, Sendulsky 1995). Inter-masting events in *Merostachys* spp. is sparsely cited in the literature and it may vary from 3 to 34 years (Pereira 1941, Giovannoni et al. 1946, Smith et al. 1981, Sendulsky 1995, 2001, Sick 1997, Guilherme & Ressel 2001, Jaksic & Lima 2003, Areta et al. 2009). Sendulsky (2001) cited a flowering cycle of 30-33 years in *M. neesii*. In the studied region, *M. neesii* clumps occur in high densities on the border and interior of secondary forests. The dry fruits of *M. neesii* have nearly 1 cm length and 0.2 cm width. Each fruit contains one seed.

3. Methodology

The presence of *S. frontalis* on Fazenda Interales State Park was verified using a modified point count method with fixed radius (Bibby et al. 1993). Thirty-three circular points with estimated fixed radius of 20 m and interspaced in a minimum distance of 10 m each other were established along 1.500 m in three trails with the presence of *M. neesii* and without any species of bamboos. The bird censuses were carried out between 6:30 to 11:00 AM. in 09 March 2010. All the individuals of *S. frontalis* seen and heard were counted during 5 minutes per point. Considering the geographical conditions of the study area and the bird movements, we judged this short census period adequate to avoid records of the same individuals of *S. frontalis* in neighboring circular points along the trails. On the same morning, seven added focal points of 30 minutes each were used to observe *S. frontalis* feeding on *M. neesii* clumps in one of the trails.

Three seed traps of 1.75 m² were also installed below the *M. neesii* infrutescences during all day (6:30 AM – 4:30 PM) to quantify the number of seeds predated. We considered a predation when the seed was removed (by the bird) from the dry fruit's sheath that completely covers it. As a result, we obtained the proportion of seeds consumed (predated) by *S. frontalis*. We presumed that the seeds were predated by *S. frontalis* due the inexistence of another bird species foraging in *M. neesii* clumps during the diurnal focal observations on the points and the mainly nocturnal feeding activity of rodents (Bergallo 1994). During all the observation time, only one individual of Uniform Finch (*Haplospiza unicolor*) was recorded moving through one bamboo clump with no active feeding behavior. Olmos (1996), reported the association of *H. unicolor* with *Chusquea meyeriana* in the same study area. There are also evidences pointing that the size and morphology of the bill of *H. unicolor* are better suited to forage in the smaller seeds of *Chusquea* spp. than on *Merostachys* spp. (Areta et al. 2009).

Results

Considering the 33 point counts, 18 had *M. neesii* clumps and we recorded eight individuals of *S. frontalis* in six points with the bamboo. Normally, only one individual per point count was recorded, except in one of the points where two individuals were recorded during an agonistic encounter. These observations indicate territoriality of the birds. Additionally, we recorded the foraging behavior of *S. frontalis* in *M. neesii* clumps in four of the seven focal points. Mean feeding rate was 1.10 ± 0.55 seeds preyed upon/minute (range: 0.53 – 2.06) (Table 1).

During the seed feeding, *S. frontalis* generally perched firmly in the main bamboo culm or in a more slender twig near the dry infrutescence extending the neck upwards, outwards or downwards to reach the fruits and pick the seeds (Figure 1). Individuals squeezed the dry fruit and removed the seed with bill movements before dropping the fruit's sheath. Birds had easy access to several dry fruits and seeds when perching in one twig.

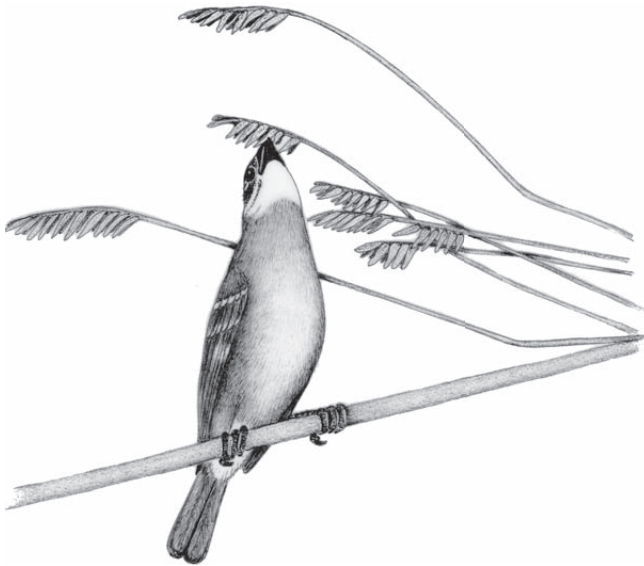


Figure 1. *S. frontalis* reaching a dry fruit of *M. neesii* in Fazenda Intervalles State Park. (Illustration by Jaime Roberto Somera).

Figura 1. *S. frontalis* alcançando um fruto seco de *M. neesii* no Parque Estadual fazenda intervalles (Ilustração de Jaime Roberto Somera).

All the seed traps had more than a half of the seeds predated, with values reaching up to 80% in two of them, indicating a high predation activity of *S. frontalis* (Figure 2).

Discussion

Synchronized masting events on bamboos are pointed out as an extraordinary example of seed predator satiation (Janzen 1976). Granivorous birds specialized on bamboos depend on the ephemeral seed resource available at large intervals of time and they have to wander actively to find these resources (Neudorf & Blanchfield 1994, Areta et al. 2009). Apparently, this is the case of *S. frontalis* in Atlantic forest (Collar et al. 1992, Sick 1997).

The masting event of *M. neesii* produces millions of seeds simultaneously, likely satiating all kinds of potential predator species (e.g. birds, rodents) (Olmos 1996, Sick 1997, Areta et al. 2009). For instance, our results estimated the mean of 19 ± 8 seeds per hour in the 1.75 m² seed traps as a coarse example of large seed production. Taking this into account, one bird might predate this amount of seeds in approximately 18 minutes. Although we did not have the precise number of birds and seed production on bamboo clumps in the entire study area, the amount of seeds predated by *S. frontalis* must be considered to the control of bamboo populations. The importance of *S. frontalis* as control species of *M. neesii* increases regarding the simultaneous spatial depletion of the seeds as resultant effect of bird territoriality. Once seeds were depleted in bamboo clumps, populations of *S. frontalis* probably will move to others suitable feeding areas.

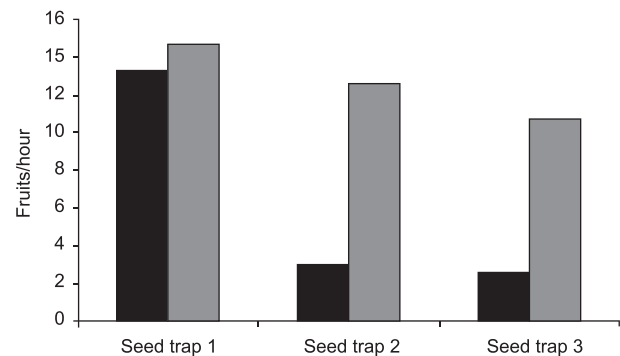


Figure 2. Number of fruits per hour collected in 1.75 m² seed traps disposed below of *M. neesii* thickets in Fazenda Intervalles State Park. The black bars are intact (non-predated) fruits and the white bars are predated fruits.

Table 1. Focal points, time of observation per point, contacts of individuals per point, and feeding activity of *S. frontalis* on seeds of *M. neesii* at Fazenda Intervalles State Park.

Focal point	Time of observation	Contact of individual*	Predated seeds	Feeding rate (seeds/minute)
#1	6:30 to 7:00	-	-	-
#2	7:05 to 7:35	-	-	-
#3	7:40 to 8:10	#1	32	1.06
		#2	41	1.36
		#3	16	0.53
#4	8:15 to 8:45	#4	62	2.06
#5	8:50 to 9:20	#5	48	0.80
#6	9:25 to 9:55	-	-	-
#7	10:00 to 10:30	#6	23	0.76

*The term contact of individual was used due the uncertainty to verify if individuals feeding on seeds were the same one. There were occasions that one bird left the bamboo clump and then a bird returned and fed upon the seeds.

S. frontalis inhabits mainly the interior and borders of forested areas (Ridgely & Tudor 1994, Sick 1997, Collar et al. 1992). These are also the areas in which the plants suffer the negative effects caused by the bamboos, mainly due to nutrients competition, obstruction of light and limitation of seed dispersal (Smith et al. 1981, Oliveira-Filho et al. 1994, Rother et al. 2009). Thus, we argue that seed predation by *S. frontalis* may render a self-species benefit effect, helping in the maintenance of their native arboreal habitats, and in turn, keeping its own populations wealthy. This endemic and vulnerable bird from the Atlantic forest has as major threats the continuing forests clearance and illegal pet trade (Collar et al. 1992, Birdlife International 2008). In some occasions, the forests destruction is faster than the bamboo fruit masting events, and local disappearance of *S. frontalis* have been reported for some Brazilian regions (Vasconcelos 2002).

In addition to *Merostachys* spp., *S. frontalis* was also present at masting events of *Guadua* and *Chusquea* bamboos in the Atlantic forest, and anthropogenic scenarios of rice cultivated areas (Sick 1997, Fitorra et al. 2008, Areta et al. 2009). Probably, this granivorous species feeds on more species of bamboos, and its predation activity contributes to reduce the predominance of Poaceae over other forest plants of this biome.

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