

**A NEW BEHAVIOR AT THE LEK BY MALE VIOLET-CROWNED PLOVERCRESTS
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ABSTRACT · Males of the Violet-crowned Plovercrest (*Stephanoxis loddigesii*) exhibit a lekking reproductive system where agonistic interactions are relatively common. Here we describe a new behavior performed when Violet-crowned Plovercrest males are alone on perches. This study was conducted in 2011 at two Violet-crowned Plovercrest leks located in semi-deciduous forests of Rio Grande do Sul, Brazil. We performed *ad libitum* observations on seven males. The new behavior is always performed by solitary males. During the displays the hovering male with raised crest, pointed the beak towards the display perch while flying sideways in semicircles or circles. This behavior is similar to aggressive displays performed in front of perched rival males. Such a display is also present in other species of hummingbirds and may help to prepare males for aggressive aerial exhibitions or, alternatively, may represent a displacement behavior.

RESUMO · Um novo comportamento em leques de Beija-flor-de-topete (*Stephanoxis loddigesii*)

Machos do Beija-flor-de-topete (*Stephanoxis loddigesii*) se agregam em leques, onde interações agonísticas são relativamente comuns. Aqui, nós descrevemos um novo comportamento que é realizado quando machos do Beija-flor-de-topete estão sozinhos nos leques. O estudo foi conduzido em 2011 em dois leques do Beija-flor-de-topete localizados em uma Floresta Semidecidual, no estado do Rio Grande do Sul, Brasil. Nós utilizamos o método de *ad libitum* para observar sete machos. O novo comportamento é realizado por machos solitários. Durante as exibições, os machos pairam no ar com os seus topetes eriçados, dirigindo seus bicos para o poleiro de corte enquanto voam lateralmente formando círculos e semicírculos. Este comportamento é similar às exibições agressivas realizadas na frente de poleiros de machos rivais. Essa exibição também está presente em outras espécies de beija-flores, e podem colaborar para preparar os machos para exibições agressivas aéreas ou, alternativamente, podem representar um comportamento de deslocamento.

KEY WORDS: Aggressive encounters · Bioacoustics · Courtship display · Hummingbirds · Lek · Territorial behavior**INTRODUCTION**

The Violet-crowned Plovercrest (*Stephanoxis loddigesii* Gould, 1831) is a small hummingbird (body mass 2.2–3.4 g, body length without bill 8.5–9.0 cm) with striking sexual dimorphism (Schuchmann 1999). Adult males of the Violet-crowned Plovercrest have a long iridescent blue crest with a conspicuous black patch on the underparts (Cavarzere et al. 2014) while females are iridescent green with a gray belly and slightly elongated crown feathers (Cavarzere et al. 2014). This species is mainly found in Brazil, from Rio Grande do Sul to São Paulo state (Cavarzere et al. 2014, Sick 1997, Schuchmann 1999), and also occurs in Argentina and Paraguay. Males have a lek-mating system, where the individuals aggregate to attract females for mating (Pizo 2012). After mating, males provide no resources or parental care to the females or offspring (Emlen & Oring 1977).

During the breeding season, from August to December, males of the Violet-crowned Plovercrest establish territories within the leks that are defended against other males (Pizo 2012). Males participate in leks that

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contain up to seven territorial males (but not always in visual contact with each other), and defense of territories is performed through visual and vocal signaling (Pizo 2012). During the breeding season, each male uses from two to five perches where the courtship behavior is performed (Pizo 2012). In addition to performing courtship displays, males also perform aerial displays during the breeding season. These displays are associated with agonistic encounters, an intruding male generally flies close and around the territory owner, which then flies off in pursuit (Pizo 2012). During agonistic encounters, these individuals maintain their crest erect while performing a series of quick lateral flights of short duration. In this study, we describe a similar type of display which, unlike the regular aerial display, is performed by adult males of the Violet-crowned Plovercrest without the immediate presence of another male.

METHODS

The study was conducted at two leks (23°40'28.9"S, 53°43'05.7"W and 29°37'54.67"S, 53°54'8.64"W) located in Santa Maria city, Rio Grande do Sul state, southern Brazil. The leks were located at an average altitude of 280 m a.s.l. The vegetation consists of Atlantic Deciduous Forest, including several stages of forest succession (Marchiori 2009).

Seven Violet-crowned Plovercrest males were observed *ad libitum* (Altmann 1974). All behaviors of males were recorded from 07:00–12:00 h and from 12:00–17:00 h between the months of September and October 2011. Each individual was observed for 10 hours over the course of seven days. During the observations, we used a video camera (Kodak EasyShare Z981) to record the behavior of individuals near the perches. The camera was placed at a distance of about 10 m away of each male to avoid disturbing their behavior. We also recorded the vocalizations associated with the display using a Sennheiser ME67 microphone connected to a Marantz PMD661 recorder (wav, 24 bit, 96 kHz). Spectrograms were obtained using the Seewave package (Sueur et al. 2008) in R version 3.3.3 (R Core Team 2016).

RESULTS

During the observations at both leks, males of the Violet-crowned Plovercrest showed a behavior hereafter referred to as “solitary aggressive display.” This display was performed when Violet-crowned Plovercrest males were alone on perches. Hovering near the perches, such solitary males would raise their crest, direct the beak towards their own display perch (or close to it), and, while flying from side to side, execute circles or semicircles, at times incline their bodies forward (Figure 1). Eleven events of solitary aggressive display were observed throughout the 70 hours of observation (seven days). In general, a single display took up to 20 seconds.

In all cases when solitary aggressive display was observed, the males emitted a characteristic vocalization (“*tipuí-tipuí*”) before starting the display. This sound consists of two syllables: the first syllable starts at about 12 kHz descending in frequency with one or two harmonics, while the second syllable is at a relatively constant frequency (~5 kHz), shorter in duration and with a greater number of harmonics (Figure 2).

DISCUSSION

During our observations, Violet-crowned Plovercrest males presented a solitary display behavior, which had been previously undescribed for the species. The movements performed during the solitary aggressive display are accompanied by a call and similar to aerial displays executed between two adult males of the Violet-crowned Plovercrest. During the latter type of display, the male intruder displays itself hovering in front of and slightly above the territory owner and then returns to its perch (Pizo 2012). This flight is performed laterally around the rival, which is perched at a lower level (Pizo 2012). The beak of the aggressor remains pointed towards the rival throughout the display. Thereafter, the attacker is usually pursued by the territory owner (Pizo 2012). On the other hand, solitary aggressive display is performed in the absence of conspecifics and directed towards an inanimate object (i.e., perch). We hypothesize that it may either constitute a form of training for the aforementioned aerial display or represent a displacement behavior in the absence of females or rivals.

Similar agonistic behavior has been observed in other species of the family Trochilidae. In males of the Blue-throated Hummingbird (*Lampornis clemenciae*), intruders hover within striking distance of the perched male rival (Ficken et al. 2002). In the Amethyst-throated Hummingbird (*Lampornis amethystinus*), males also perform a stereotyped aerial display to deter intruder males and, during the subsequent chase, the territorial male also emits a specific vocalization (Ornelas et al. 2002). Long-tailed Hermits (*Phaethornis superciliosus*) also perform aggressive hovering displays in front of rival males at the lek, which can be sometimes performed solitarily, perhaps by young birds (Stiles & Wolf 1970). Agonistic behavior observed in these species, including the Violet-crowned Plovercrest, may be related to territorial overlap among males. As male territories of the Violet-crowned Plovercrest are close to one another, and males can use more than one perch during the breeding season (Pizo 2012), occasionally perches are susceptible to visits from intruder males. Therefore, the aggressive training display could be a strategy to prepare males for aerial exhibitions against intruding males.

It is worth mentioning that in some hummingbirds aerial hovering displays are performed in the presence of females. For example, males of Grey-chinned Hermit (*Phaethornis griseogularis*) and Amethyst-

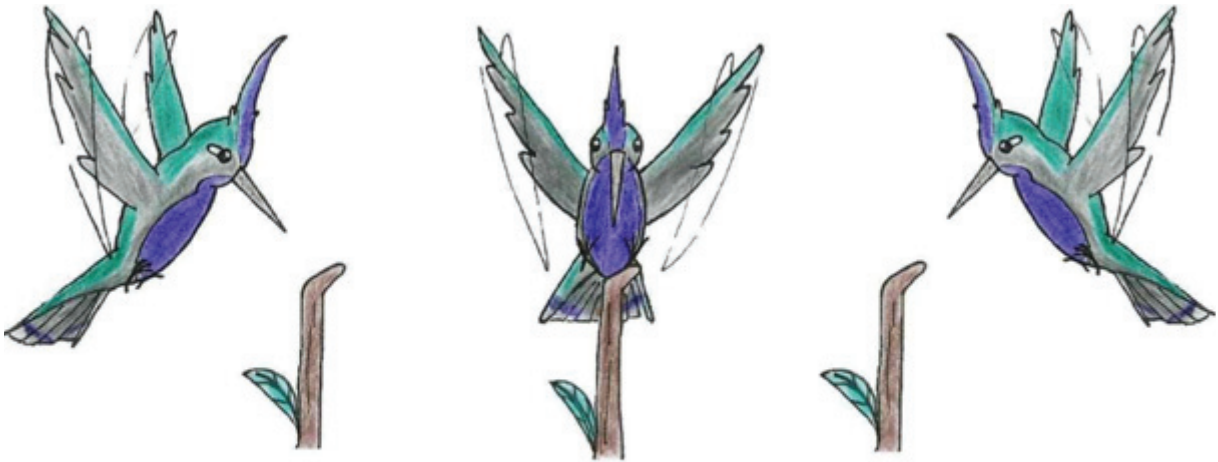


Figure 1. Schematic figure showing the sequence of “solitary aggressive display” of Violet-crowned Plovercrest (*Stephanoxis loddigesii*) males observed at leks in Santa Maria, Rio Grande do Sul, Brazil. Note raised crest, inclined body, and spread tail with beak directed towards the perch and sideward flight movements describing circles or semicircles. Schematic figure by D. Vargas-Peixoto.

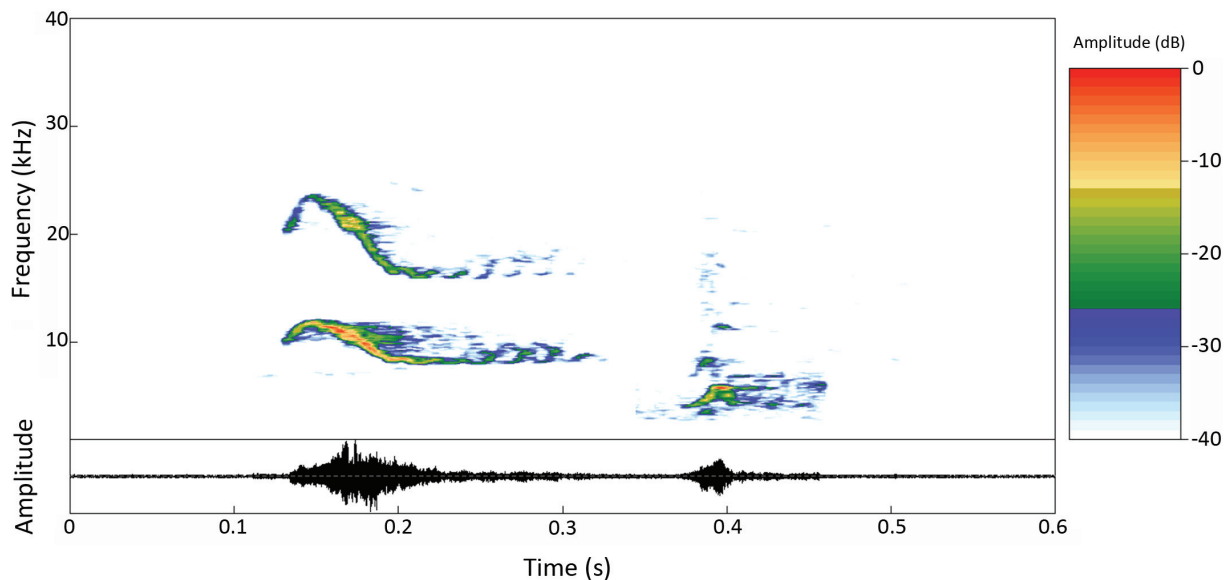


Figure 2. Spectrogram of characteristic vocalizations (“tipui-tipui”) emitted by Violet-crowned Plovercrests males (*Stephanoxis loddigesii*) before starting the “solitary aggressive display” in the perches at leks. Spectrogram produced by TV Sobroza. Recording was made by Christian Beier in São Francisco de Paula (Brazil) in October 2013.

throated Hummingbird (*Lampornis amethystinus*) perform aerial displays when a female visits the perch (Schuchmann 1987a, Ornelas et al. 2002). In addition, during courtship males of the Allen’s Hummingbird (*Selasphorus sasin*) fly tracing arcs back and forth over the female, spreading and shaking the tail in association with high-pitched sound (Wells & Baptista 1979). Males and females of the Calliope Hummingbird (*Stellula calliope*) spin around in circle in the “circle dance” (Tamm et al. 1989). Purple-throated Carib Hummingbirds (*Eulampis jugularis*) perform movements called “arc-display” (Schuchmann & Schuchmann-Wegert 1984). Finally, members of the racket-tail hummingbirds (*Ocreatus*) exhibit simple to more complex aerial displays during courtship, which may

include for-/backward and semi-circular movements, partly accompanied by high-pitched calls (Schuchmann 1987b, Schuchmann et al. 2016).

This description of the solitary aggressive display contributes to our understanding of the natural history of the Violet-crowned Plovercrest. Basic studies on natural history, such as this one, often provide background information needed for the development of theory-based studies (e.g., evolution of agonistic behavior) (Durães et al. 2011). Nevertheless, we emphasize that further studies are needed to elucidate whether the solitary aggressive display in the Violet-crowned Plovercrest is directly associated with the effectiveness of agonistic displays among males and with mating success of males during the breeding

season, or whether it simply represents a displacement behavior.

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