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Evolution of beak size and song constraints in Neotropical seedeaters (Thraupidae: *Sporophila*)

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Abstract. Many traits influence birdsong diversity. Patterns observed in the acoustic parameters can be a result of morphological constraint and can also be explained by phylogenetic relationships. Understanding morphologic mechanisms that can act on song structure might account how they can catalyze speciation and how they evolve in lineages sort. We analyzed the evolution of beak volume and song constraints in "finch-like" species of Neotropical seedeaters. We tested if beak volume limits the song structure of territorial songs, based on differences in the beaks of 19 species from the genus *Sporophila* (Thraupidae, tanagers). We also tested (1) if body size constrained song structure, and (2) if beak volume and body size were related to each other. The relationship of song parameters (e.g. maximum and minimum frequencies, frequency bandwidth and note rate) to these two morphological variables was evaluated through an analysis which phylogenetic relations were controlled (PGLS), testing a null and Brownian model. To perform a faithful analysis between morphologic and acoustic parameters, our data was based on measurements of the beak and territorial song for each individual that we analyzed. None of the analyzed parameters was related to beak volume or body mass, and beak volume was not associated with body mass. Beak volume, note rate, and minimum frequency showed a phylogenetic signal. These results do not support the theoretically motivated prediction that beak size acts as a limit on song structure in oscine birds. The shape and variations of song in *Sporophila* tanagers (Seedeaters) may be a consequence of the species' phylogenetic history, since the seedeaters showed wide plasticity in many acoustic parameters, unrelated to their beak volume and body mass. Song structure was better explained by the evolutionary relationships among the species than by morphological constraints.

Key words: acoustic communication, birdsong, diversification, oscine, bioacoustics, tanagers

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INTRODUCTION

In birds, acoustic signals are used for mate choice, territory defense, and parental communication, and are therefore a determinant factor in the life history (Catchpole & Slater 2008). Song is one of the most important traits that have the potential and capacity to drive the speciation process in birds (Catchpole & Slater 2008, Price 2008). Genetic and morphological traits can be very similar between some taxa, and acoustic signals may act as the isolating mechanism that allows differentiation of these species, preventing mutual recognition and interbreeding (Edwards et al. 2005).

Oscine birds produce a wide range of songs with different frequencies, durations, and note shapes. Songs are an extremely complex means of communication, and are produced mainly by males (Ahlstrom et al. 1971, Catchpole & Slater 2008). Acoustic signal diversity can be affected by mechanical systems, including beak size and shape and body size (Ryan & Brenowitz 1985, Podos 2001, Podos & Nowicki 2004, Podos & Moseley 2009, Martin et al. 2011, García & Tubaro 2018). Other aspects that can explain acoustic patterns in a group are the phylogenetic relationships among species, mimic capacity, and learning quality, in addition to sexual and natural selection (Ballentine et al. 2004, Ballentine 2006, Catchpole & Slater 2008, Derryberry et al. 2012). All these mechanisms that can potentially promote song diversity may increase the divergence between populations and in this way catalyze speciation (Podos et al. 2013). Birds that have innate songs should have more stable relationships between beak morphology and song structure, compared to oscines, in which these features evolve more rapidly, due to the cultural transmission of