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How many species are there within *Chamaeza campanisona* (Aves, Formicariidae)?

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INTRODUCTION & AIM

The genus *Chamaeza* comprises six species of ground-dwelling suboscine birds, adapted to the undergrowth of Neotropical forests. The species *Chamaeza campanisona*, the most widely distributed of them, measures about 20 cm and weighs around 70 g. Currently, 12 subspecies are recognized, distributed across fragmented regions of South America. Despite its wide distribution, the genus remains poorly studied from a taxonomic point of view. The sole phylogenetic hypothesis exists only in gray literature (Oliveira 2016). Taxonomic understanding of the genus currently relies primarily on a single morphological and vocal study, which clarified species boundaries among eastern Brazilian populations and resolved nomenclatural issues concerning Andean taxa (Willis 1992). Given the challenges of morphological differentiation in these cryptically plumaged birds and considering the diagnostic value of vocalizations in suboscines (whose songs are innate (Touchton, 2014), we employed bioacoustic analysis to clarify taxonomic relationships among Atlantic populations of *C. campanisona.*

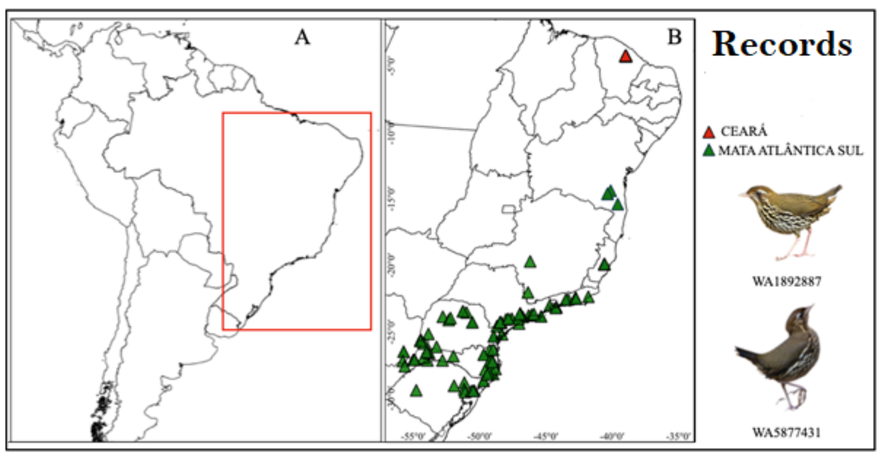

Figure 1: (A) Occurrence area of *Chamaeza campanisona* in eastern Brazil and (B) distribution of the species' song recordings in the Atlantic Forest. The photographs of the individuals are from Wikiaves (www.wikiaves.com.br).

METHOD

Vocal analysis

A comprehensive analysis of 174 audio recordings from the Wikiaves, Xeno-canto, and Macaulay Library platforms was conducted, covering the entire geographic distribution of the Atlantic populations of *C. campanisona* (Figure 1). The quantitative analysis of these recordings was performed using Raven Pro 1.6.5 (K. Lisa Yang Center for Conservation Bioacoustics, Cornell Lab of Ornithology, 2024) with standardized parameters. Eight vocal characteristics were considered: (i) highest frequency, (ii) lowest frequency, (iii) peak frequency, (iv) bandwidth, (v) maximum entropy, (vi) song duration, (vii) tempo, and (viii) number of notes. Qualitative characteristics, such as note shape, were also considered. Notes were defined as continuous lines separated by silence in a spectrogram, which is a graphical representation of sound frequency as a function of time, while phrases comprised one or a group of notes (Touchton, 2014).

Vocal characteristics were compared between groups using Multivariate Analysis of Variance (MANOVA), and differences within groups were compared using Analysis of Variance (ANOVA). Tukey's test was used to compare means between groups after ANOVA indicated significant differences.

Morphological analysis

In addition to vocal characteristics, 56 specimens of *C. campanisona* deposited in the Museu de Zoologia da Universidade de São Paulo were also evaluated. Morphometric measurements were obtained using a precision caliper of 0.01 mm and included: (i) culmen length, (ii) culmen height (at the distal edge of the nostril), (iii) culmen width (at the distal edge of the nostril), (iv) tail length (from the base between the innermost rectrices to the tip of the longest feather), (v) tarsometatarsus length (from the joint between the tarsus and the toes to the intertarsal joint), and (vi) wing length (distance from the carpal joint to the tip of the distalmost remige).

Coloration was analyzed for the (i) crown, (ii) forehead, (iii) lores, (iv) supercilium, (v) auricular region, (vi) upperparts, (vii) throat, (viii) belly, (ix) flanks, (x) primaries, and (xi) tail. Plumage coloration was analyzed by direct comparison with standardized color charts (Munsell 1994) under controlled lighting conditions.

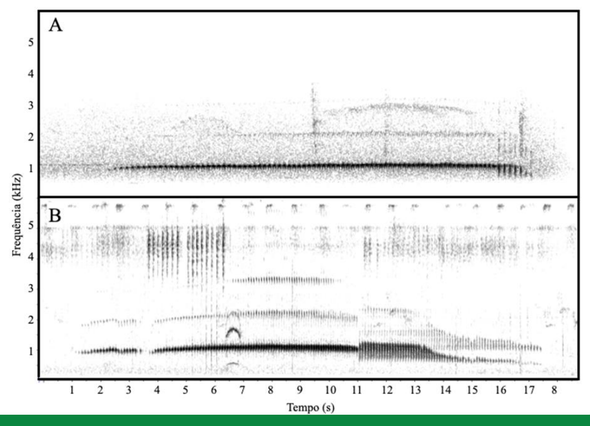

Figure 2: Spectrograms of *Chamaeza campanisona* songs from (A) Misiones, Argentina - XC52805 and (B) Serra de Baturité, Ceará - XC80404.

RESULTS & DISCUSSION

The songs are characterized by a long sequence of dozens or hundreds of notes, which ends with a descending croak (Figure 2). Three distinct vocal groups were identified among the *Chamaeza* populations: (1) a grouping from the Atlantic Forest south of the state of Espírito Santo (here identified as "South"), (2) a grouping present in the states of Espírito Santo and Bahia (here identified as "Northeastern"), and (3) the population from Ceará (here identified as "North"). The "South" and "Northeastern" groupings are more similar to each other and were shown not to be diagnosable based on the analysis along the latitudinal gradient.

The total song duration exhibited significant variation between the North population and the others (ANOVA; $p < 0.001$). Among the vocal characteristics that readily distinguish them are the number of notes (Figure 3) and the time (Figure 4), both of which are higher in the population from Ceará. These vocal variations are significant ($p < 0.001$) and show little overlap.

Morphometric analyses were not performed due to having only a single specimen available from the Ceará population. However, regarding coloration, the difference between the Ceará population and the populations south of the São Francisco River was evident. The analyzed specimen belonging to the Ceará population exhibits a cream-colored throat and breast ("pale yellow" Hue 2.5Y 8/4) compared to the white ventral plumage of other populations. Also, is evident the complete absence of the black frontal spot typically present in *C. campanisona* (Figure 5).

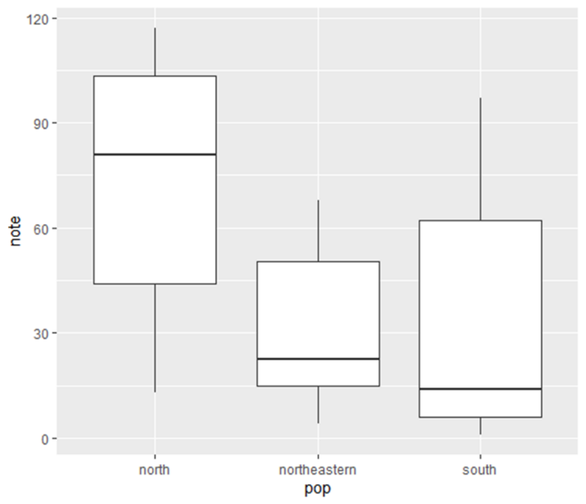

Figure 3: Comparison of populations regarding the number of notes. The x-axis represents the populations, and the y-axis represents the number of notes.

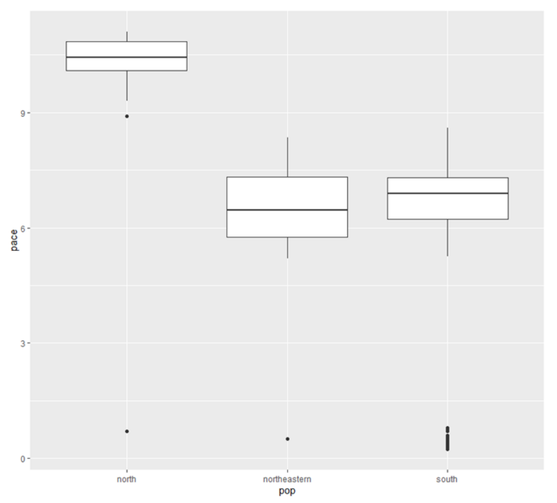

Figure 4: Comparison of populations regarding the pace. The x-axis represents the populations, and the y-axis represents the tempo.

Figure 5: Comparison of two specimens of *Chamaeza campanisona*. On the left is specimen MZUSP 33408, from Ceará, and on the right, specimen MZUSP 25678, from Minas Gerais.

CONCLUSION

This study identified two distinct song patterns in the populations of the *C. campanisona* complex from the Atlantic Forest. The southeastern population, corresponding to *C. campanisona* (Lichtenstein), is endemic to the Atlantic Forest, occurring from southeastern Paraguay and northeastern Argentina to southern Bahia in Brazil. The second population is isolated in Ceará, northeastern Brazil, with no available name. The vocal distinctions and diagnoses, as well as the difference in coloration, are compatible with a separation at the species level.

FUTURE WORK / REFERENCES

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