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SHORT NOTE

TREE COVER, PATCH STRUCTURE AND PATCH ISOLATION CORRELATE WITH PATTERNS OF TUFTED TIT-SPINETAIL (*LEPTASTHENURA PLATENSIS*) OCCURRENCE IN ESPINAL FOREST REMNANTS FROM EAST-CENTRAL ARGENTINA

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Abstract · The Tufted Tit-Spinetail (*Leptasthenura platensis*) is a common species from the southern Neotropical Region, but several ecological aspects, such as abundance patterns and habitat use, remain poorly known. I studied the relationship between Tufted Tit-Spinetail presence and characteristics of native forest patches (tree cover, patch area and interpatch distance) in eastern Buenos Aires province, Argentina. The probability of presence increased with tree cover and patch area and decreased with interpatch distance. Occurrence probability also decreased from summer to winter. Although the Tufted Tit-Spinetail is not considered a species under threat, my results show that habitat features related to forest fragmentation are major factors explaining occurrence patterns in forest patches, and suggest that it could be a species sensitive to fragmentation.

Resumen · La cobertura de árboles, la estructura del parche y el aislamiento de los parches se correlacionan con los patrones de ocurrencia del Coludito Copetón (*Leptasthenura platensis*) en remanentes de bosque del Espinal del centro-este de Argentina
El Coludito Copetón (*Leptasthenura platensis*) es una especie común del sur de la región Neotropical, pero varios aspectos de su ecología, como patrones de abundancia y uso de hábitat, son escasamente conocidos. Estudié la relación entre la presencia de Coludito Copetón y características de parches de bosque nativo (cobertura de árboles, área del parche y distancia entre parches) en la provincia de Buenos Aires, Argentina. La probabilidad de presencia de Coludito Copetón aumentó con la cobertura arbórea y el área del parche, y disminuyó con un incremento en la distancia entre parches. La probabilidad de presencia también disminuyó desde el invierno hacia el verano. Aunque no es considerada una especie bajo amenaza, mis resultados muestran que ciertas características del hábitat asociadas a la fragmentación representan factores clave que explican patrones de ocupación en parches de bosque, y apoyan la idea de que sería una especie sensible a la fragmentación.

Key words: Buenos Aires · Fragmentation · Furnariidae · Interpatch distance · *Leptasthenura platensis* · Patch area

INTRODUCTION

The Tufted Tit-Spinetail (*Leptasthenura platensis*) is a small (15 cm) member of the ovenbird (Furnariidae) family, common in moist lowland forests and dry and moist shrublands in northern and central Argentina, southeastern Brazil, Uruguay, and southern Paraguay (del Hoyo et al. 1992). It is a foliage-gleaning insectivore which hops and climbs searching for arthropods in small branches (Cueto et al. 1997, Blendinger 2005). Although its populations are considered stable in the absence of evidence for any declines or substantial threats (BirdLife International 2016), several studies have shown that the Tufted Tit-Spinetail is sensitive to habitat disturbance (e.g., Cueto & López de Casenave 2000b, Dardanelli et al. 2006, Sosa et al. 2010, Cerezo et al. 2011), and therefore should be considered a potential species of concern for conservation (Dardanelli et al. 2006).

In native remnant forests of east-central Argentina, the Tufted Tit-Spinetail is an abundant (Cueto & López de Casenave 2000a, Horlent et al. 2003) and emblematic species (Pagano & Mérida 2010). These forest remnants have faced intense logging, cattle grazing and mining in the last decades (Parodi 1940, Cueto & López de Casenave 2000b). Although common in these areas, basic aspects of Tufted Tit-Spinetail ecology have not been docu-

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mented, and abundance patterns and habitat requirements in forests fragments remain poorly known. Here, I assess the effect of patch structure (tree cover, patch size) and distribution (interpatch distance) on Tufted Tit-Spinetail presence in remnant forest patches of east-central Argentina.

METHODS

Study area. The study was carried out at "Estancia San Isidro" (35°09'S, 57°23'W) located in the Biosphere Reserve "Parque Costero del Sur", Buenos Aires province, Argentina. The area is composed mostly of grasslands and forest patches (approx. 10% forest cover) locally called "talares" (Goya et al. 1992). "Talares" grow on calcareous soil deposits, parallel to the shore of the Río de La Plata, and are composed of four main native tree species (Goya et al. 1992, Torres Robles & Arturi 2009): *Celtis ehrenbergiana* (Cannabaceae), *Scutia buxifolia* (Rhamnaceae), *Jodina rhombifolia* (Santalaceae), and *Schinus longifolia* (Anacardiaceae). In phytogeographic terms, this area corresponds to the Austral limit of "Provincia del Espinal" (Cabrera 1971). The climate is wet temperate, with mean minimum and maximum temperatures of 5.9°C and 27.5°C, respectively (Cueto & López de Casenave 2000b). Annual mean rainfall is 885 mm, with most precipitation occurring in January and February, but without a noticeable dry season (Cueto & López de Casenave 2000b).

Bird sampling. Fieldwork was carried out from 30 July to 3 December 2014 in an 81 ha plot (1,080 x 750 m). Observations were made once a week or every two weeks in 14 forest patches (sampling unit, 14 repeated measures). On a sampling day, I conducted an intensive search on each patch, walking slowly and recording Tufted Tit-Spinetail presence (either visually or aurally; Ralph et al. 1993) in a 20 m-wide transect. Accordingly, the length of transects depended on patch size (mean = 424 m, SD = 585 m, N = 14). All field observations were made within four hours after sunrise and three hours before sunset (approx. seven observation hours per sampling day). Patch order was randomized each day to reduce bias due to sampling hour.

Data analysis. Forest patches were mapped on a GoogleEarth image (September 2014). Tree cover, patch area, interpatch distance (mean distance between patch centroids), and perimeter/area ratio were estimated using the R packages maptools (Bivand & Lewin-Koh 2016) and geosphere (Hijmans 2015). To relate Tufted Tit-Spinetail presence to habitat structure I used generalized linear mixed models (Zuur et al. 2009). Since searching over extensive areas may lead to over-detection bias and because pairing behavior commonly observed in the Tufted Tit-Spinetail may inflate abundance estimates, presence-absence per patch was used as response variable instead of abundance per patch. A binomial error structure and logit function was used. Patch area was highly correlated with perimeter/area ratio ($r_s = -0.89$, $N = 14$, $p < 0.0001$) which would cause collinearity problems, so patch area was included as a surrogate for patch size. Tree cover, patch area, interpatch distance, and date were included as fixed effects (main effects plus their interactions), and patch identity was included as a random effect (Zuur et al. 2009). Date was included only as a main effect to account for temporal variation in Tufted Tit-Spinetail presence. Patch area and tree cover were log- and arcsin-transformed, respectively, to achieve linearity. Explanatory variables were standardized to mean 0 and variance 1 to both allow comparisons between model coefficients and provide numerical stability. To assess the importance of fixed effects while limiting uncertainty from model selection, a model averaging procedure was used on models fitted by maximum likelihood, which allows comparing fixed-effects structure of mixed models based on their Akaike's Information Criteria corrected for small sample sizes (AICc; Burnham & Anderson 2002). All the possible models were ranked based on their AICc and the best models were identified, i.e., the models with the smallest AICc in a range such that delta AICc < 2. The relative importance of each explanatory variable was computed as the sum of Akaike weights over all of the models in which the term appears (Burnham & Anderson 2002). A full-model averaging approach was used, in which parameters that were not included in a model were set to zero and included when averaging the coefficient estimates. Given that there could be temporal variation in tree cover due to differences in phenology between species, I carried out the same analysis excluding the winter season (leafless period of *C. ehrenbergiana*; Murriello et al. 1993). This analysis gave identical qualitative results (not shown) and thus results on the whole dataset are shown.

All analyses and graphs were done in R 3.2.1 (R Development Core Team 2015), using the packages lme4 (function *glmer*; Bates et al. 2015) and MuMIn (function *model.avg*; Barton 2015).

RESULTS

Forest patches ranged in size from 0.02 to 1.77 ha (mean = 0.42 ha, SD = 0.6 ha, N = 14), tree cover ranged from 66 to 100% (mean = 87%, SD = 12%, N = 14), patch perimeter ranged from 56.63 to 1182.70 m (mean = 396.18 m, SD = 346.6 m, N = 14) and interpatch distance ranged from 258.94 to 588.39 m (mean = 366.81 m, SD = 97.9 m, N = 14). A total of 53 Tufted Tit-Spinetails were recorded, with a mean of 0.64 individuals/ha (SD = 0.60, range = 0.00–1.86 individuals/ha, N = 196; Figure 1). Generalized linear mixed models indicated that the main factors related to habitat structure explaining Tufted Tit-Spinetail presence probability were tree cover and patch area (Table 1). In particular, the Tufted Tit-Spinetail was positively related to tree cover and patch area, and

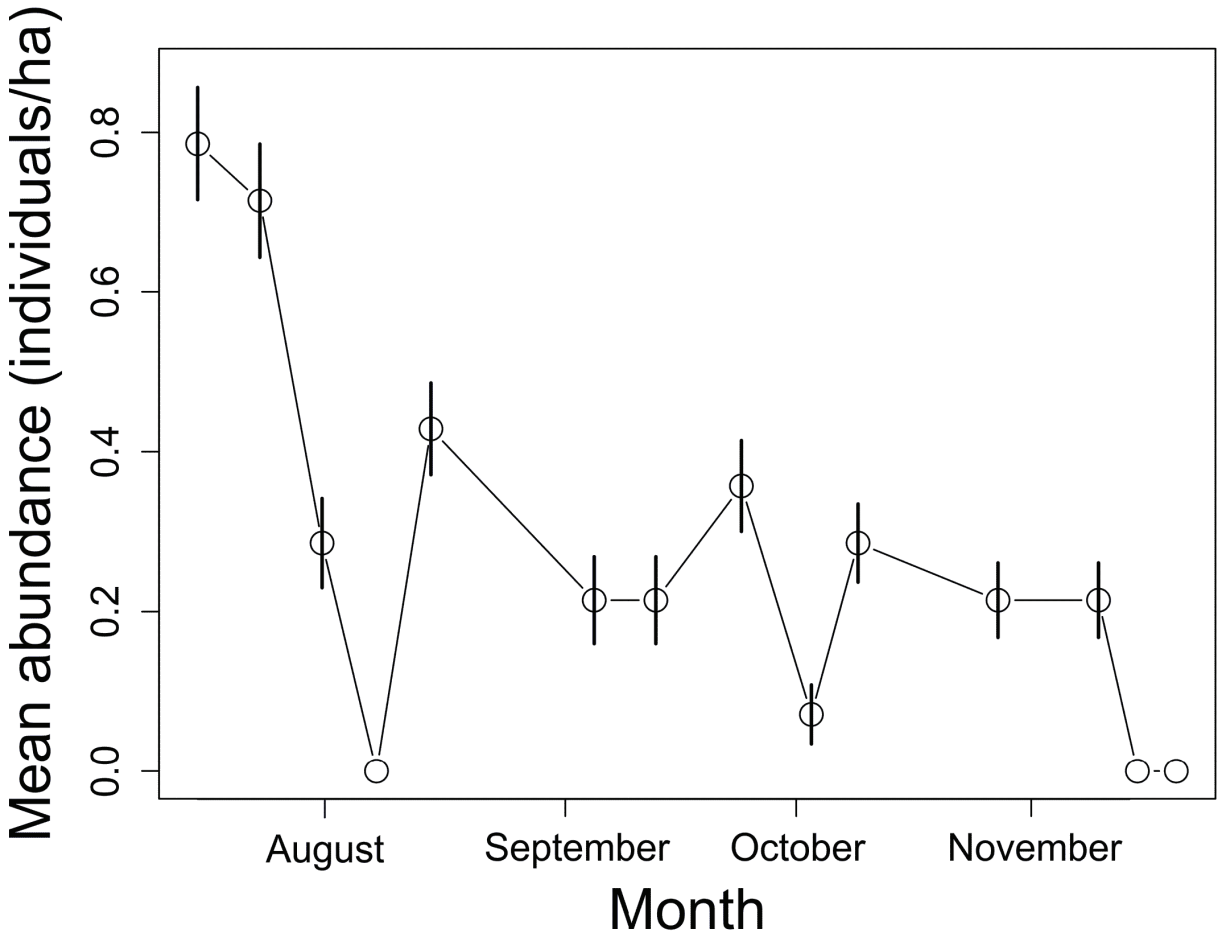

Figure 1. Temporal variation in mean abundance (white circles) of the Tufted Tit-Spinetail (*Leptasthenura platensis*) per patch (N = 14 forest patches) in Espinal forests of east-central Argentina. Vertical lines represent standard errors. Black points indicate standard errors of 0 (i.e., no variation in abundance).

also negatively related to date (Table 1). In addition, a negative interaction between interpatch distance and tree cover was retained by the average model (Table 1), indicating that the Tufted Tit-Spinetail favored less isolated patches with dense tree cover.

DISCUSSION

Tufted Tit-Spinetail presence is positively associated with large forest patches, high tree cover and low isolated patches in "talares" of east-central Argentina. These habitat characteristics probably provide the necessary resources to survive and breed, while allowing the movement of individuals between patches (Taylor et al. 1993, Martensen et al. 2008). In a study comparing bird assemblages between protected and logged forests in the same study area, Cueto & López de Casenave (2000b) found that the abundance of the Tufted Tit-Spinetail and other insectivorous birds, was lower in logged forests, which could be the result of a reduction in tree cover and, consequently, arthropod abundance (Holmes & Schultz 1988, Cueto & López de Casenave 2000b, Van Wilgenburg et al. 2001). Other studies have also shown that the Tufted Tit-Spinetail is less abundant in disturbed than in conserved habitats (e.g., Dardanelli et al. 2006, Sosa et al. 2010, Cerezo et al. 2011). For instance, Dardanelli et al. (2006) and Cerezo et al. (2011) found that this species was associated with large forest fragments in forests of central Argentina and high forest cover in farmed landscapes of east-central Argentina, respectively. In contrast to my results, Dardanelli et al. (2006) found that the minimum area requirement of the species was of at least 80 ha, which could be due to differences in patch size (0.85–280 ha vs. 0.02–1.77 ha) or distribution (e.g., larger but more isolated patches). These studies and my results suggest low tolerance to forest fragmentation and that the Tufted Tit-Spinetail could become a species of conservation concern (Dardanelli et al. 2006).

The Tufted Tit-Spinetail showed marked seasonal changes in occurrence, with a decrease in presence probability from winter to summer. This result contrasts with Cueto & López de Casenave (2000a), who found no differences between seasons in the density of insectivorous birds (including the Tufted Tit-Spinetail) in three consecutive years in the same study

Table 1. Results of generalized linear mixed modelling and model averaging analysis of the relationship between tree cover and forest patch structure in Tufted Tit-Spinetail (*Leptasthenura platensis*) presence (N = 196 observations) in Espinal forests of east-central Argentina. Generalized linear mixed models were fitted using a binomial error structure, logit function and patch identity as random effect. Patch area and percent tree cover were log- and arcsin transformed. Importance values represent the relative importance of the variables according to full-model averaging results (see Methods). Standardized model-averaged parameter estimates are shown.

Parameter	Estimate	Standard error	Importance value
Intercept	-1.54	0.30	
Date	-0.65	0.19	1.00
Tree cover	0.53	0.41	0.84
Patch area	0.44	0.39	0.72
Patch area × Tree cover	0.30	0.40	0.51
Interpatch distance	0.15	0.38	0.19
Interpatch distance × Tree cover	-0.29	0.70	0.19

area, which was attributed to the relatively mild climate and the few migrant species in the insectivore guild. Although an increase in insect abundance is expected in the breeding season (spring–summer; Mason 1985) and, consequently, in Tufted-Tit Spinetail abundance, there could be other limited resources that may affect occurrence patterns, such as nesting sites (hollows, crevices and abandoned nests; del Hoyo 1992). The observed trend could also be spurious and caused by variation in detection probability related to low individual abundance. Therefore, this result should be interpreted with caution and requires further research.

Overall, my results show that key habitat features linked to habitat loss and fragmentation, such as tree cover, patch area, and interpatch distance (Fahrig 2003) explained Tufted Tit-Spinetail presence in forest patches, and contribute to the idea that it should be considered a species sensitive to forest fragmentation.

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