SEASONAL SPACE USE AND TERRITORY SIZE OF RESIDENT SPARROWS IN THE CENTRAL MONTE DESERT, ARGENTINA

UTILIZACIÓN ESTACIONAL DEL ESPACIO Y TAMAÑO DEL TERRITORIO EN AVES GRANÍVORAS RESIDENTES EN EL DESIERTO DEL MONTE CENTRAL, ARGENTINA

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SUMMARY.—Knowledge of space use and territoriality of New World birds largely derives from studies in temperate North America and the tropics, whereas it remains poorly studied in temperate South America, particularly in arid environments. Here we studied the seasonal space use and territory size among resident individuals of three sparrows in a temperate semi-desert of Argentina: the ringed warbling-finch *Poospiza torquata*, the rufous-collared sparrow *Zonotrichia capensis* and the many-coloured Chaco-finch *Saltatricula multicolor*. Both territorial behaviour and use of space of the three species showed seasonal changes. The ringed warbling-finch and the rufous-collared sparrow used larger areas during the non-breeding season than during the breeding season, while the many-coloured Chaco-finch used areas of similar size in the two periods. Defence activities were absent for all three species during the non-breeding season. During the breeding season, each species defended territories that were smaller for the rufous-collared sparrow (0.79 ± 0.04 ha) than for the ringed warbling-finch (1.35 ± 0.04 ha) and the many-coloured Chaco-finch (1.21 ± 0.07 ha). Seasonal territoriality and territory size reported for resident individuals were similar to those reported for north-temperate sparrows in xeric environments.

RESUMEN.—El conocimiento del uso del espacio y territorialidad de aves del Nuevo Mundo viene de estudios realizados en Norteamérica templada y los trópicos, mientras que ha sido menos estudiado en Sudamérica templada, y en particular en ambientes áridos. Aquí estudiamos la variación estacional en el uso del espacio y el tamaño del territorio de tres especies de aves en un semi-desierto templado de

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Argentina: la monterita acollarada *Poospiza torquata*, el chingolo común *Zonotrichia capensis* y el pepitero chico *Saltatricula multicolor*. El comportamiento territorial y el uso del espacio variaron estacionalmente. La monterita acollarada y el chingolo común usaron áreas más grandes durante la estación no reproductiva, mientras que el pepitero chico usó áreas de tamaño similar en ambas estaciones. Para ninguna especie se observaron actividades defensivas durante la estación no reproductiva. Durante la estación reproductiva, todas las especies defendieron territorios que fueron más chicos para el chingolo común (0.79 ± 0.04 ha) que para la monterita acollarada (1.35 ± 0.04 ha) y el pepitero chico (1.21 ± 0.07 ha). La territorialidad estacional y el tamaño de los territorios de estas tres especies de aves residentes ofrecieron valores semejantes a los encontrados para especies similares en ambientes xéricos de regiones templadas de America del Norte.

INTRODUCTION

The use of space by birds often varies between the different stages of their life cycle. During the breeding season birds are restricted by their need to find mates and nest sites, while during the non-breeding season space use is more influenced by the abundance and distribution of food, and many species are free to move within the protection of a flock or to have solitary or vagrant lifestyles (Hutto, 1985; Brown *et al*., 2000). In addition, temporal and spatial resource distribution may determine the characteristics of the used areas, e.g. in terms of exclusiveness of use and size. Territorial behaviour, i.e., the defence of a defined space by exclusion of other individuals, is costly and thus must confer the benefits of monopolising the required resources to survive and/or reproduce (Brown and Orians, 1970). For example, birds are less likely to show territorial behaviour when resources are costly to monopolise (Brown, 1969). Also, resource abundance and environmental characteristics may determine the size of the areas used by birds, because when resources are abundant the area needed to fulfill individual requirements should be smaller than when resources are scarce or sparse (Schoener, 1968; Brown, 1969).

Although territorial behaviour is very common among New World birds, few studies have evaluated territoriality of passerines in temperate South America. The general objective of our research was to evaluate the seasonal space use and territoriality of resident individuals of three sparrow species in a South American semi-desert. We focused on three of the most common sparrows in the central Monte Desert of Argentina: the ringed warbling-finch *Poospiza torquata* (10 g), the rufous-collared sparrow *Zonotrichia capensis* (18 g) and the many-coloured Chaco-finch *Saltatricula multicolor* (22 g). This study provides one of the few reports on territorial behaviour of passerines in a semi-desert of South America (e.g., Lacoretz *et al*., 2012) and is the first such study of the many-coloured Chaco-finch and the ringed warbling-finch.

MATERIAL AND METHODS

We conducted our study in the open mesquite woodland of the Biosphere Reserve of Ñacuñán, MAB-UNESCO (34º 03' S - 67º 54' W), which is located in the central Monte Desert, Mendoza province, Argentina. The open woodland comprises mesquite *Prosopis flexuosa* and chañar *Geoffroea decorticans* trees scattered within a matrix of creosote shrubs (almost exclusively *Larrea divaricata*), other tall shrubs with low cover (e.g., *Capparis atamisquea, Atriplex lampa, Condalia microphylla*), perennial grasses and annual forbs. The climate is dry and

temperate, and > 75% of annual rainfall (349 mm, n = 31 years) occurs during spring and summer, with high interannual variation.

We captured birds with 30 mist nets arranged in fixed locations on a permanent 10 ha plot between November 2004 and August 2009, during two surveys in the breeding season (spring: late November, and summer: mid February), and two during the non-breeding season (autumn: mid May, and winter: early August). Adult birds were marked with numbered aluminum bands and unique combinations of colour bands, and were sexed during the breeding season according to their cloacal protuberance or brood patch development. After each mist netting survey we searched for banded birds in the permanent plot (and 50 m to 100 m beyond its limit, that is a search area of 18 ha) for a minimum of 10 days or until no new banded individuals were seen after 10 hours of search. Searches for banded birds were carried out systematically by walking through the search area at least once per day. Also, at least twice per survey event, we searched in two other 10 ha plots used for other studies located 800 m away from our plot and in the vicinity of the Biological Station (350 m away from our plot). We registered the identity of each banded individual, its location, and its activity (e.g., singing, chasing another individual, feeding alone or in a flock –at least three individuals feeding and moving together within 15 m from each other–). Relocations were georeferenced and incorporated into a Geographic Information System (GIS) in ArcView 3.3 (ESRI, 2002). We separately mapped all relocations of marked individuals during the breeding and non-breeding seasons for each year.

To assess seasonal space use we measured the maximum distance, in a straight line, between all the relocations of the same individual within the breeding and non-breeding seasons of each year. We used this proxy of home range (instead of measuring an area as we did during the breeding season) because numbers of relocations were lower during the non-breeding season given the low conspicuity of individuals. The maximum distances between relocations and territory size were highly correlated during the breeding season (Pearson correlation, r = 0.748, P < 0.001, n = 48) and allow a seasonal comparison using the same methodology. We compared maximum distances between relocations between the breeding and non-breeding seasons in two ways: (1) for those individuals that were present in both the breeding and non-breeding seasons (probably residents), and (2) including all registered individuals (i.e., also some transients that were seen only during one of the seasons may have been included). When a bird was seen during more than a year we averaged the maximum distance among relocations registered on each season throughout the study. We evaluated seasonal differences using paired Student t-tests when comparing within resident individuals and independent Student t-tests when comparing between all banded birds (with Student-Welch t-tests for heterogeneous variables when needed).

All locations of singing males were considered for territory mapping, and identification of most individuals with colour bands and the records of aggressive interactions and simultaneous songs facilitated the demarcation of territories. Territory size was calculated as a minimum convex polygon (MCP) using the Animal Movement (Hooge and Eichenlaub, 1997) and Spatial Analyst (ESRI, 2000) extensions. Differences in territory size between species were evaluated with a one way-Anova and post hoc Tukey-Kramer comparisons for unbalanced designs.

RESULTS

Distances were larger during the non-breeding season than during the breeding
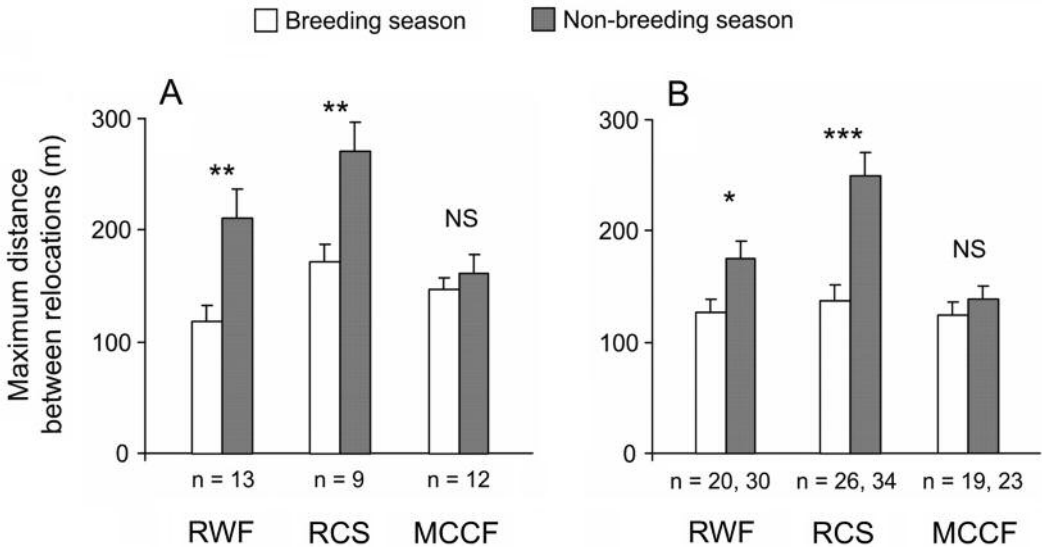
FIG. 1.—Maximum distances between relocations during the breeding and non-breeding seasons for three sparrow species in the central Monte Desert: ringed warbling-finch (RWF), rufous-collared sparrow (RCS), and many-coloured Chaco-finch (MCCF). Sample sizes (n) for (A) paired t-tests on individuals that were recorded in consecutive seasons and (B) unpaired t-tests on every registered individual throughout the study (* p < 0.05, ** p < 0.01, *** p < 0.001, NS non-significant differences). *[Distancia máxima entre reubicaciones durante las temporadas de reproducción (barras blancas) y no reproducción (barras grises) para tres especies de aves granívoras en el desierto del Monte central: monterita acollarada (RWF), chingolo común (RCS) y pepitero chico (MCCF). Tamaño muestral (n) para (A) pruebas t pareadas con individuos registrados en estaciones consecutivas y (B) pruebas t no pareadas con todos los individuos registrados durante el estudio (* p < 0,05, ** p < 0,01, *** p < 0,001, NS diferencias no significativas).]*

season for the rufous-collared sparrow and the ringed warbling-finch, but show no seasonal changes for the many-coloured Chaco-finch, both when comparing resident individuals or when including all banded birds (fig. 1). During the non-breeding season, when banded ringed warbling-finches were registered alone they were mostly within the same areas defended during the breeding season, but we often saw them in mixed or exclusive flocks (20% of observations) or feeding on exudates of mesquite trees (7%) in other locations within or outside the plot. During this season it was also quite common to locate banded rufous-collared sparrows

feeding in flocks (30%) in any location. In contrast, banded individuals of the many-coloured Chaco-finch were mainly found feeding alone or with the same mate as during the breeding season. Rarely (7%) many-coloured Chaco-finches were relocated in mixed or exclusive flocks, but always within the same areas that they defended during the breeding season.

Overall, 88% of defence activities (i.e., songs and aggressive interactions, 90% for the ringed warbling-finch, 91% for the rufous-collared sparrow, and 84% for the many-coloured Chaco-finch) were recorded during the spring, and the rest during the summer,

TABLE 1

Territory sizes (in hectares) during 2004-2008 breeding seasons of three sparrow species in the central Monte Desert. Sample size is shown in brackets after the name of the species and different letters indicate significant differences (p < 0.05) for Tukey-Kramer comparisons after a One-way Anova ($F_{2,45}$ = 29.73, p < 0.001).
[Tamaño del territorio (en hectáreas) durante las temporadas de reproducción de 2004-2008 de tres especies de aves granívoras en el desierto del Monte central. El tamaño muestral se indica entre paréntesis detrás del nombre de la especie, distintas letras indican diferencias significativas (p < 0,05) para comparaciones de Tukey-Kramer luego de un Anova de un factor ($F_{2,45}$ = 29,73, p < 0,001).]

Species	Mean ± SE	Range
Ringed warbling-finch (12)	1.35 ± 0.04[a]	1.15 – 1.58
Rufous-collared sparrow (19)	0.79 ± 0.04[b]	0.53 – 1.15
Many-coloured Chaco-finch (17)	1.21 ± 0.07[a]	0.69 – 1.74

while no aggressive interactions were observed involving banded birds during the non-breeding season. During the breeding season, males of each species sang and actively defended fixed areas, and territory size differed between species (table 1).

DISCUSSION

The behaviour and use of space of the studied sparrows showed seasonal changes. During the non-breeding season, resident individuals of the three species were seen in the same areas that they were actively defending during the breeding season, but we did not register signs of territorial defence when flocks of these and other granivorous species were feeding close to them. In Monte Desert, the availability of grass seeds (on which these birds feed during the winter, Marone *et al.*, 2008) is higher during autumn and winter, and reaches its minimum during the spring (Marone *et al.*, 1998). The period of highest seed abundance coincides with a great influx of highly mobile individuals of these and other granivorous species that usually feed in flocks (Marone, 1992; Sagario *et al.*, in press). The lack of aggressive interactions during the non-breeding season is consistent with the hypothesis that birds should "tolerate" competitors and/or join them in flocks when food and competitor abundance is high, and exclude them when resource monopolisation (e.g. of mates and nest sites) may be advantageous (Brown and Orians, 1970, Grzybowski, 1983). This pattern was observed for all three species. In contrast, we found some species to be more flexible than others with respect to the size of the areas used. For the ringed warbling-finch and the rufous-collared sparrow their tendency to flock may explain the use of larger areas during the non-breeding season as compared to the many-coloured Chaco-finch. In other arid and semiarid systems some small species of seed-eating birds were also reported to be sedentary during the breeding season and to move much larger distances during the non-breeding season (e.g., Dean, 1997; Brandt and Cresswell, 2008). However, as was observed for the many-coloured

Chaco-finch, in those same systems there are species with very limited movements throughout the year (Grybowski, 1983; Gordon, 2000). Therefore, movement strategies may not be predicted solely by the abundance and distribution of food, and other factors not considered here, such as species-specific differences in the costs and benefits of flocking and/or in needs for sources of drinking water (Herrera, 1979; Wiens, 1991), may explain space use during the non-breeding season.

Territorial defence was common during the breeding season. The rufous-collared sparrow had smaller territories than the many-coloured Chaco-finch and ringed warbling-finch. Territory size is positively correlated both with body size and the inclusion of animal material into diets (Schoener, 1968). Despite being the smallest, the relatively large territory size of the ringed warbling-finch might be explained by its different feeding behaviour during the breeding season, when it mainly takes arthropods (López de Casenave *et al*., 2008). However, also, differences in availability of nest sites might influence territory size and thus explain differences between the three species. The ringed warbling-finch and many-coloured Chaco-finch mainly select *Geoffroea decorticans* and *Capparis atamisquea*, respectively, to build their nests (Mezquida, 2003), plant species with less than 5% coverage in the study area. The rufous-collared sparrow, in contrast, builds its nest mainly on the ground (Mezquida, 2003).

It is worth mentioning that the average territory size for the rufous-collared sparrow found in this study (0.79 ± 0.04 ha) was noticeably larger than that found for the same and other species of the genus in tropical or temperate mesic habitats (0.07-0.55 ha, Miller and Miller, 1968; Formica *et al*., 2004). This difference may reflect the lower environmental quality of the central Monte. Accordingly, the average territory size for all three species was within the range reported

for small sparrows in north-temperate xeric ecosystems (0.50-1.90 ha Wiens *et al*., 1985; Wheelwright and Rising, 1993). Therefore, both territory size and seasonal changes in territorial behaviour were in accordance with a markedly seasonal xeric environment such as the Monte. However, long-term studies are needed in order to understand the mechanisms that explain both seasonal and interspecific differences in the use of space of Monte Desert sparrows.

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