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ARTICLE

Year-round presence of Slaty Thrush (*Turdus nigriceps nigriceps*) in mountains of central Argentina

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ABSTRACT: The migration patterns of passerine species in the Neotropical region present several gaps of knowledge. The migratory behavior of the Slaty Thrush (*Turdus nigriceps nigriceps*) has been well characterized in their central and northern distribution along eastern slopes of the Andes from Argentina to Ecuador. The Slaty Thrush was historically considered a migrant breeder in the southern extreme of their distribution. In the present study, we show new evidence of the resident status of this species in its southernmost distribution on western slopes of Sierras Grandes and Sierras de Comechingones in Córdoba Province, Argentina. There, the Slaty Thrush has a year-round presence only at sites invaded by fleshy-fruited alien plants. The main invasive plants form dense patches of vegetation and offer an abundant fruit supply that is highly consumed by this bird species during autumn–winter, when there are no native fruits available. We suggest that the Slaty Thrush was a migrant species in past decades, but the recent invasion by fleshy-fruited species could explain its actual year-round presence by providing fruit in a period of the year of food shortage and new suitable habitats.

KEY-WORDS: Chaco Serrano Woodland, Córdoba, nonbreeding season, plant invasion, western Sierras Grandes.

INTRODUCTION

Several species of the Turdidae family are distributed over the different Argentinian ecosystems (Mazar-Barnett & Pearman 2001), but the ecology of some of them is still poorly understood (Collar 2005). Slaty Thrush (*Turdus nigriceps*) is a medium size thrush (21.5 cm). Males are mostly dark gray above, blacker on the crown and have a white throat sharply streaked blackish; females are basically brown where males are gray, though some gray shows on the sides and flanks (Ridgely & Tudor 2009). According to Sibley & Monroe (1993), the Slaty Thrush have a controversial taxonomic status with two currently recognized subspecies distributed alopatrically (Collar 2005, Remsen-Jr. *et al*. 2015; it is considered as two full species for Ridgely & Tudor 2009). Both subspecies are mainly frugivorous and occasionally consume arthropods and earthworms (Rougès & Blake 2001, Collar 2005).

Turdus nigriceps subalaris is an uncommon breeder in humid forests and woodlands in eastern Paraguay, southeastern Brazil and northeastern Argentina. In austral winter, this subspecies migrates to non-breeding areas in northern to southern central Brazil (Ridgely & Tudor 2009, but see Vogel 2014). *Turdus nigriceps nigriceps* is a fairly common breeder in montane forest and woodland on eastern slopes of the Andes from western Bolivia (Cochabamba and southern Beni) to northwestern Argentina (the southernmost distribution in La Rioja and Córdoba Provinces). The breeding season begins in November–December and ends in January–February, when nestlings leave the nests (Collar 2005). In austral winter (June–September) populations at the southern end of the distribution migrate north following the Andean forests and reach eastern Peru. At the northern end of their distribution, *T. nigriceps* is resident and breeds in montane woodlands and even in scrublands from southwestern Ecuador (mainly Loja) to northwestern Peru (northern Cajamarca and Lambayeque; see Figure 1; Ridgely & Greenfield 2001). In Argentina, *T. nigriceps* is a partial migrant in the southern Yungas of Tucumán, Jujuy and Salta Provinces (Rougès & Blake 2001, Capllonch *et al.* 2008), and Collar (2005) suggests they may undertake altitudinal movements. Details about the migratory behavior of this species in its southernmost distribution remains unclear (see Collar 2005 and Appendix I in Capllonch *et al.* 2008).

In Córdoba Province, the Slaty Thrush was historically considered a scarce summer migrant (Nores *et al.* 1983, Yzurieta 1995) because of the absence of winter records until the last decade of the 20th Century (M. Nores,

pers. comm.). However, recent records during the non-breeding period questioned the actual migratory status of the subspecies in the southernmost area of its distribution (Barri *et al.* 2015). In this area, the Slaty Thrush inhabits humid ravines of the Chaco Serrano woodlands (Yzurieta 1995, Figure 1) from 900 to 1500 m a.s.l. (Luti *et al.* 1979, Cabido *et al.* 1998). Currently, many areas of this region suffer from anthropogenic alterations such as plant invasions, urbanization, and periodic fires (Hoyos *et al.* 2010, Giorgis & Tecco 2014, Argañaraz *et al.* 2015). These alterations modify the environmental physiognomy and food resource abundance and availability (Hoyos *et al.* 2010, Tecco *et al.* 2013). Some invasive plants such as *Pyracantha* spp., *Ligustrum lucidum* and *Morus alba* produce fleshy fruits that are widely consumed and dispersed by birds like Slaty Thrushes (Vergara-Tabares *et al.* 2016). Fruit production by these plants may alter the temporal availability of this resource (Vergara-Tabares *et al.* 2016), because they produce fruits in periods of food scarcity (*i.e.* autumn-winter, Tecco *et al.* 2013). Thus, fleshy-fruited plant invasions may be involved in a switch of Slaty Thrush behavior from migratory to resident. In the present study we (1) report the year-round presence of Slaty Thrush in its southernmost distribution in Chaco Serrano woodlands, and (2) discuss the potential effect of fleshy-fruited invasive plants on the residence status of the Slaty Thrush.

METHODS

Study area

The study was carried out in six sites located on western slopes of Sierras Grandes and Sierras de Comechingones between 900 to 1300 m a.s.l., Córdoba Province, Argentina (Figure 1). The topography of each selected site is characterized by a ravine where runs a stream. All six sites present a plant assemblage corresponding to the Chaco Serrano woodland (Luti *et al.* 1979). Mean annual precipitation in the area is approximately 700–800 mm (concentrated in summer) and mean annual temperature is 17.5°C (data taken at the station La Ventana; Acosta *et al.* 1992). The dominant wood species are *Lithraea molleoides*, followed by *Acacia caven*, *Celtis ehrenbergiana* and *Bouganvillea stipitata*. Among dominant shrub plants are *Heterothalamus alienus*, and species of the genera *Flourensia* sp. and *Baccharis* spp. (Cabido *et al.* 1998). Three sites (Las Calles, San Javier, and Los Hornillos; red areas in Figure 1) are invaded by fleshy-fruited plants. The most abundant invasive shrubs correspond to fleshy-fruited *Pyracantha angustifolia* and *P. atalantoides*, and to a lesser extent *Ligustrum lucidum*, *Morus alba*, and *Olea europea*. Both *P. angustifolia* and *P. atalantoides* as well as *L. lucidum* and *M. alba* are native from southeast Asia. Some of these species, including *P. angustifolia* and *P. atalantoides*, occasionally form dense patches of vegetation and produce fruit during autumn–winter, when native fruit is scarce or absent (Vergara-Tabares *et al.* 2016). The other three sites (Las Rabonas, Travesia and Luyaba; green areas in Figure 1) do not have fleshy-fruited invasive plants. In order to control for aspects that may affect the presence of Slaty Thrush, we selected the six sites regarding its altitude (between 900 and 1100 m a.s.l.) and similarity in plant community (mountain forests dominated by *L. molleoides*). As the maximal distance between study sites (*i.e.* Las Rabonas to Luyaba) is approximately 50 km, it is probable that climatic conditions (precipitation or temperature) among all sites did not vary greatly.

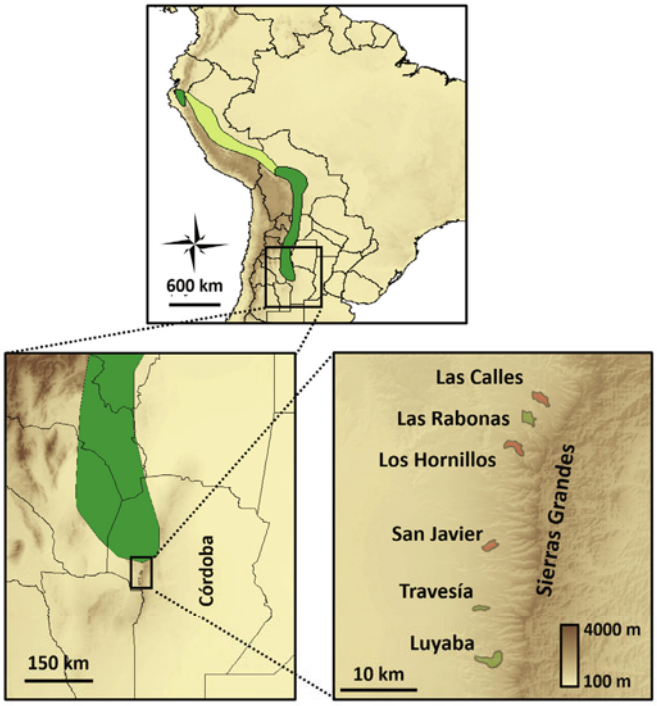

FIGURE 1. Distribution of Slaty Thrush (*Turdus nigriceps nigriceps*) and the southern portion of its distribution where we conducted fieldwork. In the upper frame, we show the distribution of the western subspecies of Slaty Thrush (*sensu* Ridgely & Tudor 2009); dark green in the northern part of the distribution shows the range of resident and breeder populations that inhabit southern Ecuador and northern Peru; light green shows the areas where Slaty Thrush visits during the austral winter; and dark green in the southern part of the distribution indicates the breeding areas during austral spring-summer. In the right frame, we show our six study sites. Red areas indicate invaded sites by fleshy fruited *Pyracantha* shrubs; from north to south: Las Calles, Los Hornillos, and San Javier. Green areas indicate sites that have not been invaded by alien plants; from north to south: Las Rabonas; Travesía, and Luyaba.

Sampling methods

We performed visual and aural searches of Slaty Thrush during April, July and September in 2014 and during January, May, August, October and December 2015.

In both years we looked for Slaty Thrush along an unstructured trail of three km along the ravine of each study site. These searches consisted of 4 h walks along the study sites during the morning or afternoon, and we recorded the number of individuals of Slaty Thrush detected. During 2014, we sampled three sites (Los Hornillos, San Javier and Luyaba, Table 1), and during 2015 we sampled the remaining six sites mentioned.

TABLE 1. Number of individuals of Slaty Thrush (*Turdus nigriceps nigriceps*) captured using mist nets and number of individuals of this species recorded during unstructured trails in the southern end of their distribution during April, July, and September 2014. The study sites included those invaded by exotic fleshy fruited plants: Los Hornillos and San Javier, and a non-invaded site: Luyaba.

Habitat	Locality	April		July		September	
		Captures	Trails	Captures	Trails	Captures	Trails
Invaded	Los Hornillos	3	7	4	11	3	10
	San Javier	4	15	9	25	12	18
Non Invaded	Luyaba	2	1	0	0	0	0

We also used mist nets during between 20–29 April, 10–19 July, and 20–29 September 2014 at three sites (Los Hornillos, San Javier, and Luyaba; Table 1). Nets were mounted in sites with more intense bird activity and were separated by at least 50 m (*i.e.* near the streams and/or between patches of arboreal vegetation). Once captured, the birds were aged by looking at the bill and leg color that appear with dark irregular spots when the individual is immature. Sex was determined based on plumage, as this species has sexual dichromatism. Birds were ringed on their right leg with a color ring. In addition, feces produced by birds during the captures where collected to identify plants consumed. We opened four 12-m nets from sunrise to 12:00 h and from 16:00 h to sunset during three successive days (approximately 108 h/net per site).

During 2015, we performed a minimum of 20 point counts (a total of 772 point counts) in each of the six sites to detect and count Slaty Thrushes (three among these six sites where the same where we used mist nests in the previous year; Figure 1 & Table 2). At each site, point counts were separated by at least 150 m to avoid double-counts between neighboring points. Point counts were established along the same unstructured trails where we conducted the visual and aural surveys. At each point, the researcher waited 5 min as a settling down period before starting counts (Bibby *et al.* 1992). Slaty Thrush individuals occurring within a 50-m fixed radius of each point were recorded visually or aurally. Observations were made during 10 min at each point count and we surveyed only under favorable weather conditions, within a 4-h period after sunrise. Point counts were conducted between 6–11 January, 1–6 May, 1–6 August, 10–15 October, and 26–31 December.

Data analysis

To evaluate the effect of presence of *Pyracantha* shrubs and sampling period on Slaty Thrush abundance we used a two way GLM with interaction (Zuur *et al.* 2009). We used the bird abundance obtained from surveys in trails conducted during 2015 as response variable and condition (with two levels: invaded and non-invaded) and the period (with five levels; Table 2) as factors. The six study sites were used as replicates, three invaded (Las Calles, Los Hornillos and San Javier) and three non-invaded (Las Rabonas, Travesía and Luyaba). A negative binomial error distribution was used to deal with overdispersion in abundance data. Analyses were performed using the software R (R Core Team 2014) and the package glmmADMB (Skaug *et al.* 2012).

TABLE 2. Number of individuals of Slaty Thrush (*Turdus nigriceps nigriceps*) registered throughout point counts and unstructured trails during January, May, August, October, and December 2015. In that year the study sites were Las Calles, Los Hornillos, and San Javier (invaded); and Las Rabonas, Travesía, and Luyaba (non-invaded). The number of point counts by month and locality are indicated in parenthesis and the number outside the parenthesis indicates the total number of birds recorded in point counts.

Habitat	Locality	January		May		August		October		December	
		Count points	Trails	Count points	Trails	Count points	Trails	Count points	Trails	Count points	Trails
Invaded	Las Calles	0 (30)	1	0 (28)	1	0 (28)	2	0 (20)	0	1 (20)	3
	Los Hornillos	2 (37)	12	3 (30)	18	2 (29)	15	2 (20)	5	5 (20)	9
	San Javier	1 (30)	18	4 (29)	14	12 (30)	21	8 (22)	26	5 (29)	12
Non Invaded	Las Rabonas	0 (29)	2	0 (20)	2	0 (25)	0	0 (20)	0	4 (21)	4
	Travesia	0 (30)	0	0 (29)	0	0 (30)	0	0 (20)	0	0 (20)	0
	Luyaba	0 (39)	0	0 (28)	0	0 (29)	0	1 (20)	0	0 (20)	1

RESULTS

Slaty Thrush was registered during all sampling periods only in two of the sites invaded by non-native plants (Los Hornillos and San Javier) during 2014 and 2015 (Table 1 & 2). During April 2014 we captured and registered thrushes at all study sites (*i.e.* Luyaba, Los Hornillos and San Javier). During July and September 2014, we only captured and recorded thrushes at invaded sites (*i.e.* Los Hornillos and San Javier; Table 1). We captured two individuals with immature plumage only in July at Los Hornillos, and two females in September in San Javier. We collected feces from two individuals from Los Hornillos during July and three individuals from San Javier during September. In all of the feces we found seeds of *L. molleoides* and *Pyracantha* sp.

The GLM analysis showed that only the condition (invaded or non-invaded) affected Slaty Thrush abundance, being the abundance higher at invaded sites ($\chi^2_{1,27}$ = 34.04, P < 0.001), while the interaction between condition and period, or period alone, did not affect bird abundance (Table 2 & Figure 2).

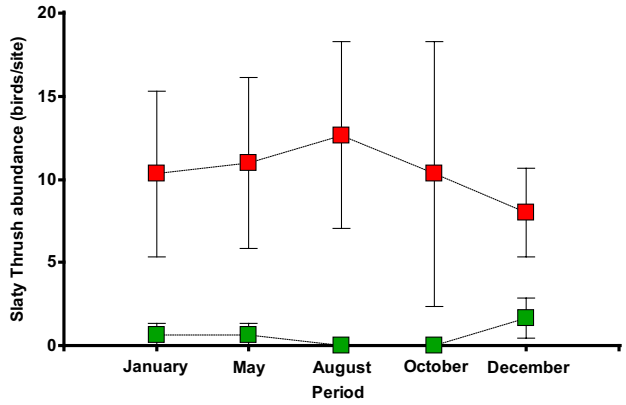

FIGURE 2. Mean abundance of Slaty Thrush per site observed in trails during 2015 in relation to sampling period, and particionated by invaded and non invaded condition. Green box indicates non invaded sites and red box indicates sites invaded by *Pyracantha* shrubs. Boxes show standard error.

DISCUSSION

There is a gap in the current literature about the migratory status of Slaty Thrush in the southern areas of its distribution (Collar 2005). Our observations indicate that Slaty Thrush has a year-round presence in some sites characterized by invasive fleshy-fruit species (mainly *Pyracantha* shrubs) at the southern end of its distribution. Contrary to documented partial migratory behavior in northern Argentina (Capllonch *et al.* 2008), our data supports the recent consideration of Slaty Thrush as a resident species in a reduced area of their southern distribution (Barri *et al.* 2015). Previous records at Córdoba Province (during the 1980's and 90's) were only obtained during the breeding season (November to February – Nores 1996, Capllonch *et al.* 2008, M. Nores, pers. comm.). If Slaty Thrush was a migrant that left southern areas in past decades, the current resident behavior may be plausibly explained by recent anthropogenic environmental changes, such as invasion by fleshy-fruited exotic plants. Our results show that Slaty Thrush was more abundant throughout the year in invaded *vs.* non-invaded areas, not only during the fruiting period of invasive plants (Table 2), ruling out the suggestion that the presence of the Slaty Thrush may be only related to invasive fleshy fruit during autumn–winter. The pattern of presence observed suggests that plant invasion by *Pyracantha* species would have an effect on resident behavior of Slaty Thrush, maybe due to the generation of adequate micro or mesohabitats and the availability of fruits during periods of fruit scarcity. Although the magnitude of plant invasion in our study sites is lesser than other regions in Chaco Serrano Woodland (*e.g.* Hoyos *et al.* 2010), the density, size and scattered distribution of patches of invasive plants may be sufficient for Slaty Thrush requirements. There is evidence supporting the positive effects of fleshy fruited invasive plants on abundance of frugivorous birds (*e.g.* Gleditsch & Carlo 2011, Vergara-Tabares unpubl. data) and other researches have documented cases where individuals and populations respond rapidly to changing environmental conditions, leading to a modification in their migratory behavior (*e.g.* Berthold *et al.* 1992, Whittington *et al.* 1999).

Slaty Thrush has been considered a partial migrant species, showing high seasonal fluctuations, and being more abundant during the breeding season in spring-summer in the southern Yungas (Capllonch *et al.* 2008, Rougès & Blake 2001). In contrast, we obtained a similar number of records of the species throughout the year during 2014 and 2015, mainly at sites invaded by exotic plants. At non-invaded sites, the presence of Slaty Thrush was variable, occurring mainly during the breeding season, despite at a lower frequency than in invaded areas. In addition, it is important to highlight that our study area was located at the southernmost end of the distribution of Slaty Thrush. This situation allows us to discard the possibility that the Slaty Thrush found here did not belong to a southern locality.

From a general perspective regarding the distribution of Slaty Thrush, previous evidence supports a resident status at the northern end of their distribution (Fjeldså & Krabbe 1990, Best *et al.* 1993, Rasmussen *et al.* 1996), while other studies reveal a uniquely winter presence of the species in the eastern Andes of central and southern Peru (Schulenberg 1987, Walker 2001). Finally, Capllonch *et al.* (2008) analyzing twenty years of data, revealed the migratory behavior of Slaty Thrush mainly in the Yungas

of northwestern Argentina, and Collar (2005) does not rule out altitudinal movements of this species. Our data suggests that Slaty Thrush has a resident behavior in the southern extreme of its distribution, clearly associated with sites invaded by fleshy fruited plants. If Slaty Thrush was a migrant species in past decades, the recent invasion by fleshy fruited plants and environmental changes caused by such invasion may explains the recent year-round presence of this species, through the creation of micro and/or mesohabitats and availability of fleshy fruits during autumn–winter.

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