ORNITOLOGIA NEOTROPICAL 22: 15–24, 2011

MIGRATORY BIRDS IN THE SEMI-ARID CAATINGA SCRUBLANDS OF NORTHEASTERN BRAZIL: DIVERSITY AND SEASONAL PATTERNS

Juan Ruiz-Esparza[1,2], Patrício Adriano da Rocha[1,3], Daniela Pinheiro Bitencurti Ruiz-Esparza[2], Adauto de Souza Ribeiro[4], & Stephen F. Ferrari[4]

[1]Graduate Program in Ecology and Conservation, Universidade Federal de Sergipe, Av. Marechal Rondon s/n, 49100-000, São Cristóvão, Sergipe, Brazil.

[2]PRODEMA, Universidade Federal de Sergipe, Av. Marechal Rondon s/n, 49100-000, São Cristóvão, Sergipe, Brazil.

[3]Graduate Program in Zoology, Universidade Federal da Paraíba, Centro de Ciências Exatas e da Natureza, Cidade Universitária, 58059-900, João Pessoa, Paraíba, Brazil.

[4]Department of Biology, Universidade Federal de Sergipe, Av. Marechal Rondon s/n, 49100-000, São Cristóvão, Sergipe, Brazil. *E-mail:* ferrari@pq.cnpq.br

Resumo. – Aves migratórias na Caatinga do Nordeste de Brasil: diversidade e padrões sazonais. – Cerca de 330 espécies de aves neárticas migram anualmente para a região neotropical, algumas até o extremo meridional da América do Sul. Os migrantes austrais tendem a se deslocar ao longo de distâncias mais curtas, frequentemente dentro da América do Sul, e muitas espécies realizam migrações parciais. Entretanto, sabe-se muito pouco sobre as rotas migratórias ou os padrões de migração adotados pela maioria destas aves. Com o objetivo de um melhor conhecimento de padrões de migração no Nordeste brasileiro, dois pontos de amostragem foram estabelecidos no bioma da Caatinga na Serra da Guia em Sergipe. Amostras mensais padronizadas (3 dias de coleta com rede de neblina) foram coletadas em cada ponto entre outubro de 2008 e setembro de 2009. Um total de 98 espécies foi capturado, das quais 24 foram classificadas como sendo pelo menos migrantes parciais (incluindo uma espécie neártica, *Vireo olivaceus*). Treze destas espécies eram tiranídeos. Um pouco mais da metade dos 283 espécimes capturados pertenciam a duas espécies – *Elaenia chilensis* e *Turdus amaurochalinus*. Um pico foi registrado no número de espécies e de indivíduos entre março e julho, período que coincide com o pico de precipitação e de produtividade da área de estudo. Placas de incubação foram registradas em 11 espécies, e somente entre março e setembro. Dois tiranídeos (*Myiarchus tyrannulus* e *Myiophobus fasciatus*) contrariaram a tendência geral por ser capturados somente entre novembro e fevereiro (não-reprodutivos). A maioria das outras espécies foram migrantes parciais ou foram coletadas tão infrequentemente que foi impossível determinar padrões sazonais com confiança. Para estas espécies, seria necessário um monitoramento mais detalhado para definir padrões de migração com maior clareza.

Abstract. – Some 330 Nearctic bird species are known to migrate annually to the Neotropics, some as far as southern South America. Austral migrants tend to travel much shorter distances, often within South America, and many species engage in partial migrations. However, little is known of the routes or migration patterns followed by most of these birds. With the aim of better understanding migration patterns in northeastern Brazil, two sampling points were established in the Caatinga scrublands at Serra da Guia (Sergipe). Standardized monthly samples (3 days of mist-netting) were collected at each site between October 2008 and September 2009. A total of 98 species was captured, of which 24 were classified as being at least partial migrants (including one Nearctic species, *Vireo olivaceus*). Thirteen of these spe-

cies were flycatchers (Tyrannidae). Just over half the 283 specimens captured belonged to two species, *Elaenia chilensis* and *Turdus amaurochalinus*. A peak was recorded in both species and the number of individuals between March and July, coinciding with the Austral winter and peak precipitation/productivity in the study area. Brood patches were recorded in 11 species, only between March and September. Two flycatchers (*Myiarchus tyrannulus* and *Myiophobus fasciatus*) contradicted the general trend by being captured only between November and February (non-breeding). Most other species were partial migrants or collected too infrequently to permit a reliable analysis of seasonal patterns. For these species, additional monitoring would be required to define migration patterns more clearly. *Accepted 10 December 2010.*

Key words: Caatinga, diversity, migration, northeastern Brazil, seasonality, Tyrannidae.

INTRODUCTION

A number of migratory birds overwinter in tropical regions of Brazil (Telino Jr. *et al.* 2003). They include species from both the northern and the southern hemispheres (classified according to the areas in which they breed: Hayes 1995). While some Nearctic species migrate over 10,000 km from the Arctic Circle, others engage in more modest translocations on either a regional or local scale (Stotz *et al.* 1996). In general, Austral migrants cover much shorter distances than their Nearctic counterparts, and less than 15% travel as far north as the Amazon basin. This group is dominated by a few families, such as the Tyrannidae, Fringillidae, and Anatidae (Alves 2007).

In some areas, local and regional scale migrations are relatively common in Neotropical birds. In Central America and southeastern Brazil, for example, some birds - in particular, frugivores and nectarivores - undertake seasonal migrations between different altitudes (Alves 2007). Local or short-distance migrations are often very difficult to detect, especially where observations are limited or when only a part of the population migrates. Partial migrations of this type have been observed in flycatchers (*Elaenia*: Medeiros & Cavalcanti 1987, Marini & Cavalcanti 1990) and hummingbirds (*Amazilia*: Cavalcanti 1990) in the Cerrado savannas of central Brazil and in cuckoos, doves, flycatchers, and seed-eaters in the Caatinga (Olmos *et al.* 2005).

Migratory behavior and routes vary considerably among taxonomic groups. Passeriformes tend to move across terrestrial landscapes, through forests, savannas and prairies as well as anthropogenic environments (Luna *et al.* 2003), whereas other groups, such as the charadriiforms, are typical of coastal habitats, and often fly long distances over open sea (Navarro & Benítez 1998).

Few data are available on local migrations in South American birds (Alves 2007). In Brazil, there is a need for a more systematic approach to this phenomenon, which should include not only information on the presence or absence of species at a given site but also their relative abundance during different periods. In particular, the definition of migration routes can only be achieved by the consolidation of data from the field with information available in the literature and from museum specimens. With the exception of Marini & Cavalcanti (1990), such initiatives are non-existent in Brazil.

Here, data are presented on the spatial and temporal distribution of migratory birds from a site in the semi-arid Caatinga of northeastern Brazil. A clear pattern of seasonality was recorded in terms of the number of both species and individuals, which were considerably more abundant

during the early Austral winter, although a few species presented the opposite trend.

METHODS

The study was conducted in the Serra da Guia (09°57'47"S, 37°51'54"W), which is part of Serra Negra, a small range located in the municipalities of Poço Redondo in the Brazilian state of Sergipe and Pedro Alexandre in Bahia (Fig. 1). The area is typical of the semi-arid Caatinga of northeastern Brazil, although there is a small area (~20 ha) of humid forest at the top of the outcrop.

The climate of the area is characterized by relatively low levels of precipitation (mean annual precipitation = 573.40 mm), with a rainy season during the Austral winter, between April and August (SEMARH, 2010). The rains also tend to be highly unpredictable in terms of both precipitation levels and their timing (Fig. 2). Minimum temperatures varied between 17°C and 23°C and maxima were between 28–37.5°C.

Two locations were selected for the collection of data, representative of local differences in altitude and vegetation. Site 1 (09°58'09"S, 37°51'52"W) was located in caatinga vegetation at an altitude of 420 m a.s.l. (Fig. 2). Arboreal vegetation is 6–8 m high and typical trees, such as *Amburana cearensis* and *Caesalpinia pyramidalis* as well as licuri palms (*Syagrus coronata*) and mandacaru cacti (*Cereus jamacaru*), were recorded in this area.

Site 2 was located approximately 1.5 km south of the first (09°58'55"S, 37°52'06"W), within the humid forest at up to 750 m a.s.l. Fig. 2). The canopy is 12 to 16 m high and characterized by an abundance of orchids and bromeliads and a predominance of trees of the family Myrtaceae, especially *Eugenia candoleana*.

Birds were captured in standardized monthly samples at the two sites between October 2008 and September 2009. Each month, 10 mist nets (12.0 m x 2.5 m, with a 20 mm mesh) were set at each site for three days in the morning (05:00–12:00 h) and late afternoon/evening (16:00–21:00 h). Captured birds were removed carefully from the nets and placed in cloth bags for transfer to the field laboratory for processing. Species identification was based on the field guides of Major *et al.* (2004) and Sigrist (2007).

A standard set of data were collected for each specimen including sex, total length, wing length, reproductive condition, and capture date/time. The migratory species were identified according to the classification of Stotz *et al.* (1994). All captured animals were marked with color-coded, 2.5 mm-wide plastic cable ties, which were attached to the tarsus. The collection and marking of specimens was authorized by the Brazilian Environment Institute (IBAMA), through scientific license 15900-1, issued by SISBIO. The combination of different colors in specimens of each species permitted the recognition of individuals when recaptured (Peach *et al.* 1991).

RESULTS

During the course of the study period and based on 6000 net-hours, a total of 925 individuals was captured, representing 98 species from 27 families. Twenty-four of these species (24.5%) were migratory (Table 1) according to the classification of Stotz *et al.* (1994), although they contributed a disproportionate number of captures, with 283 individuals or 30.6% of the total.

A quarter of these migratory species were captured only once during the study, and most others were caught too infrequently to permit a systematic analysis of possible seasonal variation. However, a number of patterns are apparent from the data (Fig. 3a). There was, for example, a peak in the number of both species and individuals captured between March and July, which coincides with the early

FIG. 1. Location of the two study sites at Serra da Guia, within the Serra Negra, northeastern Brazil.

part of the Austral winter, and was only slightly different from the period of peak precipitation (Fig. 2). During this period, between seven and 11 species were recorded each month, in contrast with between two and seven in the remaining seven months of the year.

A similar pattern was observed in the number of individuals captured (Fig. 3b), with 18–79 specimens being captured per month between March and July, and only 10–18 in the rest of the year. The upper limit of this range of values was due to a major influx of Chilean Elaenia (*Elaenia chilensis*), which was represented by 65 specimens in June, in contrast with no more than 10 in any other month. The month with the next largest number of specimens captured was March, with just 33 individuals.

Three species, all tyrant flycatchers, presented a marked seasonal distribution (Fig. 4). Two of these were *E. chilensis* and the Olivaceous Elaenia (*Elaenia mesoleuca*). These two species were only captured between March and July, but while the numbers of *E. chilensis* peaked in July, *E. mesoleuca* was more common earlier, peaking in April. The third species, the Brown-crested Flycatcher (*Myiarchus tyrannulus*) presented a quite distinct pattern and was only captured between November and January.

Two other tyrant flycatchers presented seasonal trends, but were captured too irregularly to permit the definition of a clear seasonal pattern. The Southern Bearded Tyrannulet (*Camptostoma obsoletum*) was absent between October and January, but while it was captured each month during the rest of

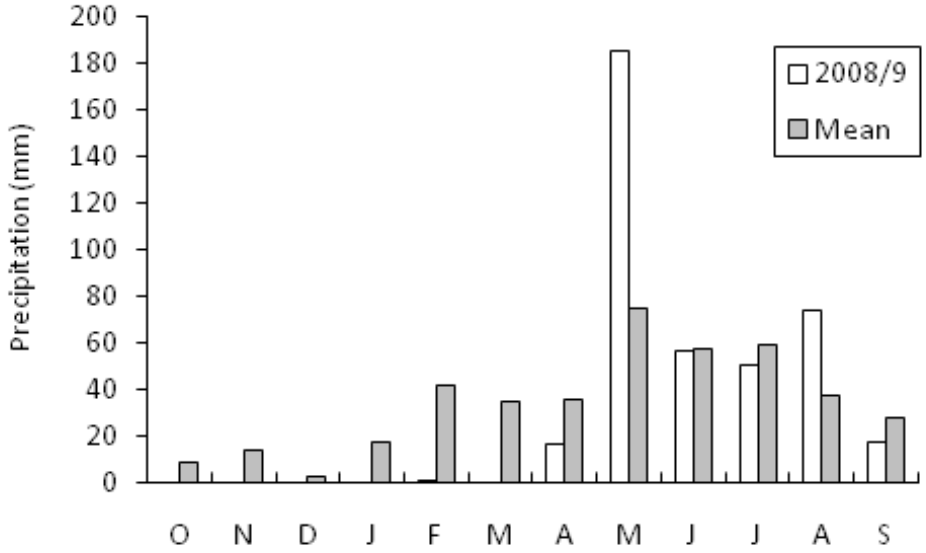

FIG. 2. Monthly precipitation recorded at the meteorological station in Poço Redondo, Sergipe, Brazil during the study period, and mean values for the period 2003–2007.

the year (with the exception of February when three specimens were captured) no more than two specimens were captured in any one month. By contrast, 10 specimens of the Bran-colored Flycatcher (*Myiophobus fasciatus*) were captured between November and February, while the species was recorded in only one other month (July, 2 specimens).

Another species, the Creamy-bellied Thrush (*Turdus amaurochalinus*), was present throughout most of the year but, like *E. chilensis* and *E. mesoleuca*, peaked in abundance between March and July (Figure 5) when 40 (76.9%) of the 52 specimens were captured. This species also accounted for almost two-fifths (10 of 26, or 38.5%) of the specimens captured with brood patches, which were only recorded between March and July.

Brood patches were observed in almost half (11) of the migratory species (Table 1), including *T. amaurochalinus*, but only once in most other species, except for *E. chilensis*, *E. mesoleuca*, and Tawny-crowned Pygmy Tyrant (*Euscarthmus meloryphus*) with two specimens each and *C. obsoletum* with four specimens. Brood patches were recorded in the latter species between June and September and, overall, only between March and September. March was the peak month in terms of the number of individuals, due in part to the predominance of *T. amaurochalinus* (seven specimens), while this month and June yielded the largest number of species with brood patches (five each). Brood patches were not observed in either *M. tyrannulus* or *M. fasciatus*, even though a total of 28 specimens were captured.

DISCUSSION

Local migration patterns are notoriously difficult to detect, especially where only a part of the population engages in such behavior (Alves 2007). Tyrant flycatchers of the genus *Elaenia* are among the birds that engage in this type of migration (Medeiros & Cavalcanti 1987; Marini & Cavalcanti 1990),

TABLE 1. Migratory bird species captured at the Serra da Guia, Sergipe (Brazil) between October 2008, and September, 2009. Species in which brood patches were recorded are indicated by an asterisk (*). Migrant status according to Stotz *et al.* (1996): Partial Austral Migrant (PAM), Austral Migrant (AM), Partial Nearctic Migrant (PNM) and Nearctic Migrant (NM). N[1] = total number of specimens captured.

Taxon	Status	Individuals captured per month												
		N[1]	J	F	M	A	M	J	J	A	S	O	N	D
Caprimulgidae														
Caprimulgus parvulus	PAM	7			2		1		1	1	2			
Columbidae														
Columbina picui	AM	7	2	1	1			1					2	
Cuculidae														
Coccyzus melacoryphus	PAM	2*						1	1					
Emberizidae														
Zonotrichia capensis	PAM	10*		1		4	2							3
Thraupidae														
Hemithraupis guira	PAM	1							1					
Sporophila bouvreuil	PAM	1											1	
Thraupis sayaca	PAM	6			1			1	1	1				2
Volatinia jacarina	PAM	2								1			1	
Tityridae														
Pachyramphus polychopterus	PAM	3*			2		1							
Turdidae														
Turdus amaurochalinus	AM	52*	1	1	15	5	2	1	17	5	3	2		
Tyrannidae														
Camptostoma obsoletum	PAM	14*		3	2	2	1	1	1	2	2			
Elaenia chilensis	AM	91*			7	6	10	65	3					
Elaenia flavogaster	PAM	5								3	2			
Elaenia mesoleuca	PAM	25*			1	17	1	6						
Elaenia spectabilis	AM	15*	5	1		1			4					4
Empidonomus varius	PAM	1	1											
Euscarthmus meloryphus	PAM	3*			1			1			1			
Megarynchus pitangua	PAM	4*				1		1						1
Myiarchus tyrannulus	PNM	16	3										8	5
Myiopagis viridicata	PAM	1*			1									
Myiophobus fasciatus	PAM	12	3	4					2				1	2
Pitangus sulphuratus	PAM	1											1	
Tyrannus melancholicus	PAM	3			1	1		1						
Vireonidae														
Vireo olivaceus	NM	1												1

and were also prominent in the present study. *Elaenia chilensis* is distributed throughout the Andes between Colombia and Patagonia and migrates seasonally to Uruguay, Paraguay, and Brazil (Meyer de Schauensee 1970). In the present study, the species was captured only between March and July, with a marked peak of abundance in June. A similar pattern was recorded at the Raso da Catarina, in Bahia, to the southwest of the present

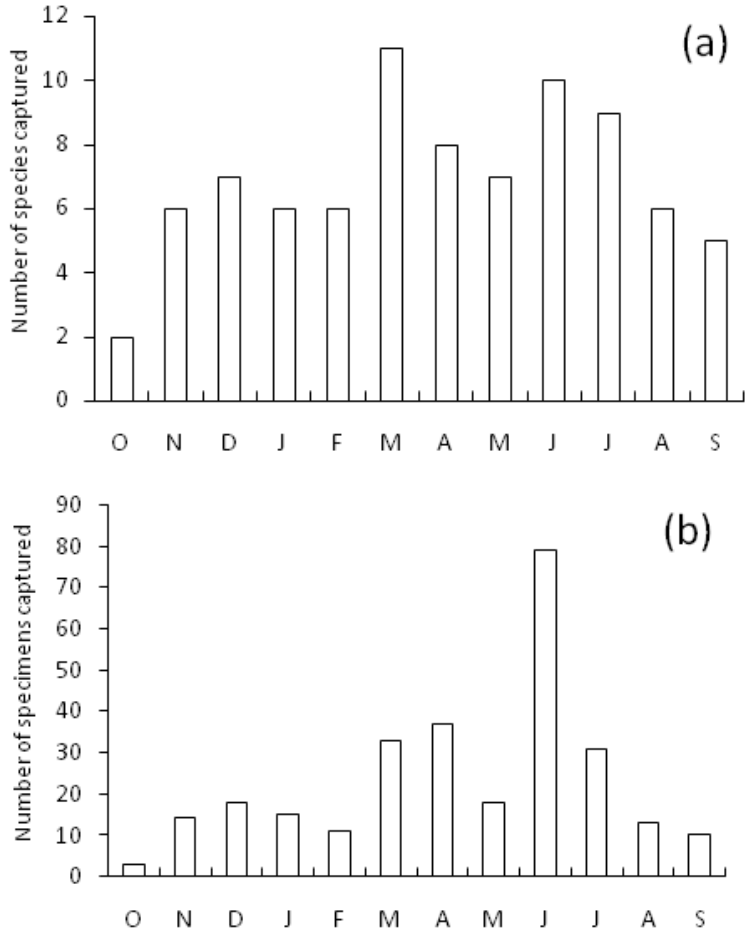

FIG. 3. Number of migratory species (a) and specimens (b) captured during the study period at the Serra da Guia, Sergipe (Brazil).

study area, where Lima (2003) recorded a peak in abundance between April and June. This suggests a protracted wave of migration through the Brazilian northeast following the summer nesting season further south and west.

A second species, *E. mesoleuca*, which occurs primarily in southern South America, presented a similar pattern of abundance, as did a third tyrant flycatcher, *C. obsoletum*. While less exclusively seasonal, a fourth species, *T. amaurochalinus*, presented a similar pattern of increased abundance during the rainy season (Austral winter). The brood patches observed in individuals of all four species indicate some reproductive activity during this period, which is the Caatinga's most productive season, due to precipitation levels. During the same period, at higher southern latitudes, the climate is dry and cool. This pattern would be especially relevant to both *E. chilensis* and *T. amaurochalinus*, which are classified as

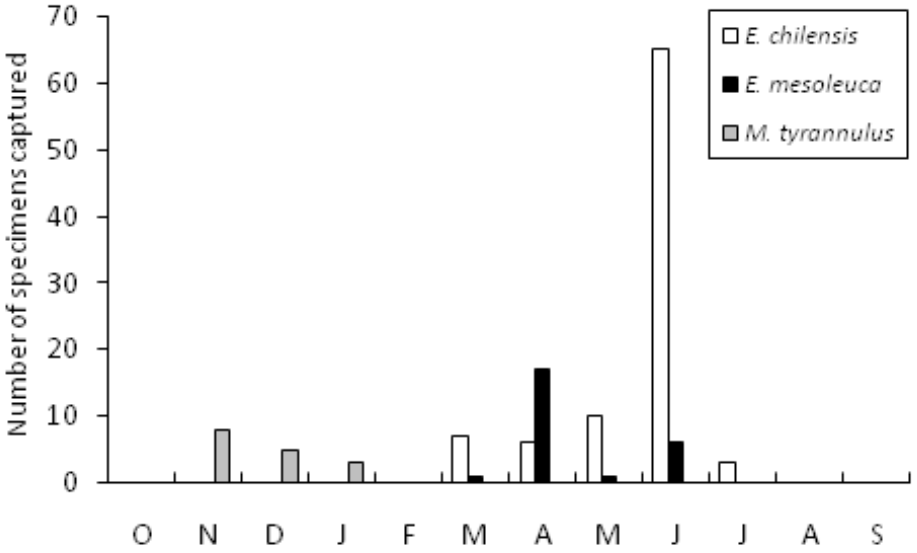

FIG. 4. Number of specimens of three tyrannid species captured during the study period at the Serra da Guia, Sergipe (Brazil).

Austral migrants by Stotz *et al.* (1996). By contrast, *E. mesoleuca* and *C. obsoletum* are classified as partial Austral migrants by the same authors (Table 1).

Large-scale seasonal migrations are known in some South American thrushes, when populations that breed in the south move to hotter northern latitudes (Alves 2007). *Turdus amaurochalinus* occurs throughout Brazil, although it is present at some sites only during the migratory period (Sick 1997). In some areas, the influx of migrants adds to the resident population, which may have been the pattern observed in the present study, although it is unclear whether the individuals with brood patches are residents or migrants. Piratelli (1999) recorded a similar pattern of abundance in the central Brazilian state of Mato Grosso do Sul.

The presence of *M. tyrannulus* at the study site during the Austral summer months is consistent with its classification as a partial Nearctic migrant (Table 1). The absence of individuals with brood patches is consistent with a pattern of overwintering at southern latitudes. The other species present exclusively in the dry season, *M. fasciatus*, is classified as a partial Austral migrant, so it is not clear exactly why it was present in the study area during this period. The only true Nearctic migrant recorded during the study, the Red-eyed Vireo (*Vireo olivaceus*), was also observed during the boreal winter (December), as expected, but with only a single specimen captured it is not possible to evaluate seasonal patterns. However, rainfall patterns vary considerably within the Caatinga, which may mean that some of the records represent local migrations within the biome. The small number of specimens captured for some species may have been at least partly a result of the sampling procedure, which favored the capture of understory species. In particular, this may explain the capture of only a single specimen of the Great

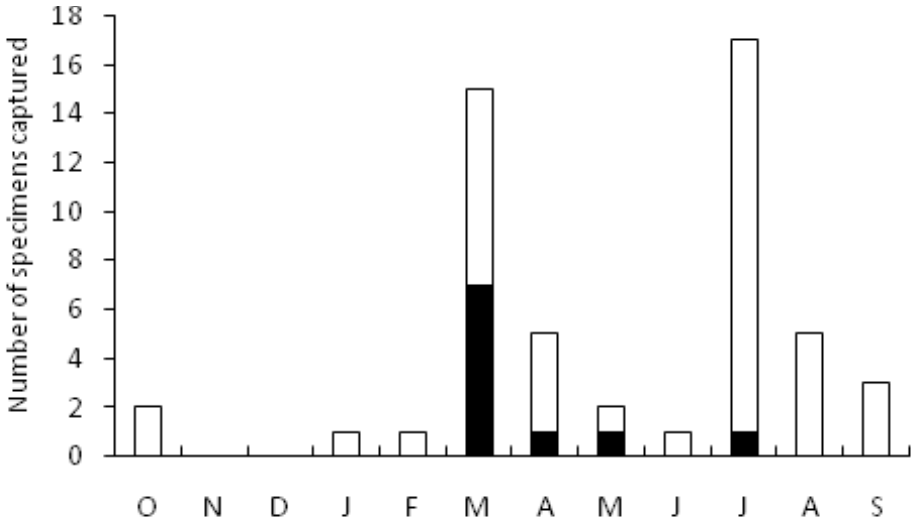

FIG. 5. Number of specimens of *Turdus amaurochalinus* captured during the study period at the Serra da Guia, Sergipe (Brazil) with (black) and without (white) brood patches.

Kiskadee (*Pitangus sulphuratus*) which was relatively abundant at the site, based on qualitative observations, but was probably not captured more often due to its preference for the upper forest strata. Similar considerations probably apply to other species, such as the Boat-billed Flycatcher (*Megarynchus pitangua*). More reliable data on seasonal patterns in the distribution of these species would require complementary sampling through systematic observations.

Overall, the results of the present study revealed distinct seasonal patterns in the local abundance of a number of migratory species, which are present in the Caatinga primarily during the Austral winter when the eastern areas of this biome are characterized by seasonal rains and relatively high productivity (Sampaio *et al.* 2002, Hernández 2005, Zanella & Martins 2005). The predominant pattern is an influx of Austral migrants, predominantly tyrant flycatchers (Tyrannidae), which presumably migrate from more southern latitudes following variation in resource abundance, although some species, such as *E. chilensis*, may be migrating more locally within the Caatinga. Much more comprehensive sampling over a wider area will be needed to better define the migratory patterns outlined here.

ACKNOWLEDGMENTS

We thank the Sergipe State Environment Secretary (SEMARH), and in particular Sidney Gouvéia and Validineide Santana, for logistic support, the Sergipe State Science and Research Foundation, FAPITEC-Sergipe (JMREA) and the Brazilian Graduate Training Program, CAPES (PAR) for graduate stipends, and the Brazilian National Research Council, CNPq, for financial resources (project numbers 302747/2008-7 and 476064/2008-2). We also thank IBAMA/SISBIO for granting a special license for the collection of specimens. We are especially grateful to Josefina "Zefa da Guia" for her support, and to Juliana Cordeiro, Douglas Matos, Thiago Bicudo for their assistance in the field.

REFERENCES

Alves, M. A. S. 2007. Sistemas de migrações de aves em ambientes terrestres no Brasil: exemplos, lacunas e propostas para o avanço do conhecimento. Rev. Bras. Ornitol. 15: 231–238.

Cavalcanti, R. B. 1990. Migrações de aves no cerrado. Anais do IV Encontro Nacional de Anilhadores de Aves, Univ. Federal Rural de Pernambuco, Recife, Brazil.

Hayes, F. E. 1995. Definitions for migrant birds: what is a Neotropical migrant? Auk 112: 521–523.

Hernández, M. I. M. 2005. Besouros Scarabaeidae (Coleóptera) da área do Curimataú, Paraíba. Pp. 367–378 *in* Araújo, F. S., M. J. N. Rodal, & M. R. V. Barbosa (eds). Análise das variações da biodiversidade do bioma Caatinga: suporte a estratégias regionais de conservação. Ministério do Meio Ambiente, Brasília, Brazil.

Lima, P. C., S. S. dos Santos, & R. C. F. da Rocha. 2003. Levantamento e Anilhamento da Ornitofauna na Pátria da Arara-Azul-de-Lear (*Anodorhynchus leari*, Bonaparte, 1856): um complemento ao Levantamento realizado por H. Sick, L. P. Gonzaga e D. M. Teixeira, 1987. Atual. Ornitol. 112: 11.

Luna, E. J. A., L.E. Pereira, & R. P. I. Souza. 2003. Encefalite do Nilo Ocidental, nossa próxima epidemia? Epidemiol. Serv. Saúde 12: 7–19.

Major, I., S. J. L. Gonzaga, & R. Castro. 2004. Aves da Caatinga. Associação Caatinga and Edições Demócrito Rocha, Fortaleza, Brazil.

Marini, M. A., & R. B. Cavalcanti. 1990. Migrações de *Elaenia albiceps chilensis* e *Elaenia chiriquensis albivertex* (Aves: Tyrannidae). Bol. Mus. Para. Emílio Goeldi, sér. Zool. 6: 59–67.

Medeiros, R. C. S., & R. B. Cavalcanti. 1987. Biologia de duas espécies do gênero *Elaenia* (Aves: Tyrannidae) em cerrados de Brasília, DF. P. 243 *in* Congresso Brasileiro de Zoologia, XIV. Resumos. Juiz de Fora, Brazil.

Meyer De Schauensee, R. 1970. A guide to the birds of South America. Oliver and Boyd, Edinburgh, UK.

Navarro, A., & H. Benítez. 1998. El dominio del aire. Fondo de cultura económica. Ciudad Mexico, D.F., Mexico.

Peach, W. J., S. Baillie, & L. Underhill. 1991. Survival of British Sedge Warblers *Acrocephalus schoenobaenus* in relation to West African rainfall. Ibis 133: 300–305.

Piratelli, A. J. 1999. Comunidades de Aves de subbosque na região leste de Mato Grosso do Sul. Ph.D thesis, Universidade Estadual Paulista, São Paulo, Brazil.

Sampaio, E. V. S. B., A. M. Giulietti, J. Virgínio, & C. F. L. Gamarra-Rojas. 2002. Vegetação & Flora da Caatinga. Associação Plantas do Nordeste/Centro Nordestino de Informações sobre Plantas, Recife, Brazil.

SEMARH. 2010. Centro de Meteorologia da SEMARH/SRH. Downloaded from http://www.semarh.se.gov.br/meteorologia/

Sick, H. 1997. Ornitologia brasileira. Editora Nova Fronteira, Rio de Janeiro, Brazil.

Sigrist, T. 2007. Guia de campo, aves do Brasil Oriental. 1ª ed. Avisbrasilis, São Paulo, Brazil.

Stotz, D. F., J. W. Fitzpatrick, T. A. Parker III, & D. K. Moskovits. 1996. Neotropical birds: ecology and conservation. Univ. of Chicago Press, Chicago, Illinois, USA.

Telino-Júnior W. R., S. M. Azevedo-Júnior, & R. M. Lyra-Neves. 2003. Censo de aves migratórias (Charadriidae, Scolopacidae e Laridae) na Coroa do Avião, Igarassu, Pernambuco, Brasil. Rev. Bras. Zool. 20: 451–456.

Zanella, F. C. V., & C. F. Martins. 2005. Abelhas (Hymenoptera, Apoidea, Apiformes) da área do Curimataú, Paraíba. Pp. 379–391 *in* Araújo, F. S., M. J. N. Rodal, & M. R. V. Barbosa (eds). Análise das variações da biodiversidade do bioma Caatinga: suporte a estratégias regionais de conservação. Ministério do Meio Ambiente, Brasília, Brazil.