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THE ARRIVAL OF BARN SWALLOWS (*HIRUNDO RUSTICA*) TO A NEOTROPICAL CITY IS RELATED TO PRECIPITATION IN WINTERING AREAS

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Resumen. – La llegada de la Golondrina tijereta (*Hirundo rustica*) a una ciudad Neotropical está relacionada con la precipitación en áreas de invierno. – En este trabajo exploramos las relaciones entre dos factores ambientales de gran escala (i.e., lluvia, temperatura) y la llegada de la Golondrina tijereta (*Hirundo rustica*) a una ciudad Neotropical mexicana en los últimos 13 años (1997–2009). La temperatura no mostró relación con la llegada de las golondrinas, sin embargo encontramos una relación significativa positiva entre la precipitación en el área Mexicana de invierno durante el mes de Febrero (un mes previo a la fecha de llegada) y la fenología migratoria de las golondrinas. Parece que la relación entre la fecha de llegada de la Golondrina tijereta y la precipitación en el área Mexicana de invierno durante el mes de Febrero es debida a la reducción en la velocidad y/o progresión de vuelo bajo condiciones ambientales no favorables. En un escenario de cambio global, la fecha de llegada de la Golondrina tijereta podría cambiar en un futuro debido a la alteración en los patrones de precipitación.

Abstract. – We studied the relationship between two macro-scale environmental factors (i.e., rainfall, temperature) and the arrival of Barn Swallows (*Hirundo rustica*) to a Mexican Neotropical city in the past 13 years (1997–2009). Temperature was not related to arrivals, but February rainfall in Mexican wintering lands (one month prior to arrival date) showed a significant positive relationship with the migratory phenology of Barn Swallows. We believe that the relationship between February rainfall in Mexican wintering lands and the arrival of Barn Swallows to Morelia is related to the reduction of flying speed and/or progression under unfavorable environmental conditions. Thus, in a global change scenario, the arrival date of Barn Swallows could change in the future in response to altered precipitation patterns. *Accepted 6 January 2010.*

Key words: Barn Swallow, bird migration, climate change, environmental variables, rainfall, temperature.

INTRODUCTION

Migratory birds move seasonally from one area to another seeking the most favorable environments to their needs at different times of the year (Lincoln *et al.* 1998). Although photoperiod has been identified as the main environmental trigger of bird migration (Berthold 1996), other environmental variables, such as temperature, rainfall, and wind have

been related to the migratory phenology of birds (see Gordo 2007 and references therein). Particularly, Neartic-Neotropical bird migration has been proved to be flexible, adjusting in response to weather variations (Marra *et al.* 2005). In fact, previous studies have reported that migrant birds arrive earlier under warmer conditions, possibly influenced by climate warming (Butler 2003, Murphy-Klassen *et al.* 2005, MacMynowski *et al.* 2007).

The Barn Swallow (*Hirundo rustica*) is a worldwide distributed landbird (Brown & Bomberger-Brown 1999). In North America, this species is a long-distance migrant. It breeds from central Canada (65°12'–51°18'N) to central-northern Mexico (22°56'–20°51'N), and winters from central-southern Mexico to South America (55°45'S). However, breeding and wintering areas overlap at mid-latitudes in central Mexico, where some populations are year-round and others spring migrants from February to June (Brown & Bomberger-Brown 1999).

Although little is known on the environmental variables that affect Barn Swallow migration in the New World, warmer conditions in the Iberian Peninsula have been related to early Barn Swallow arrivals to Britain (Huin & Sparks 1998), and drier conditions in the Sahel (Africa) delay its arrival to Spain (Gordo & Sanz 2006). Also, Barn Swallow arrival date has been related to their breeding success (Møller 1994), and thus shifts in their arrival dates may affect individual fitness.

In this study, we evaluated the role that two climatic variables play in determining the arrival of Barn Swallows to the city of Morelia (west-central Mexico). For this purpose, we sought for possible relationships between two changing macro-scale environmental variables (i.e., temperature, rainfall) and the arrival date of the swallows in the past 13 years (1997–2009).

METHODS

Study area and field observations. This study was conducted in the city of Morelia, Michoacán (west-central Mexico; 19°42'07"N, 101°11'33'W; ~ 1925 m a.s.l.). We sought for Barn Swallows within the city through intensive observations (3–5 per week) starting in late January during the past 13 years (1997–2009). Reported Barn Swallow arrival dates to the city of Morelia correspond to the number of days elapsed since January 1st and our first record of this species in Morelia (referred as "arrival day" hereafter). Due to the conspicuity of this swallow and the intensiveness of our surveys, we strongly believe that our first Barn Swallow record denotes an accurate datum of the arrival day of Barn Swallows to the city of Morelia in the past 13 years.

Data analysis. We evaluated possible relationships between temperature and rainfall with the arrival day of Barn Swallows. Because Barn Swallows have both year-round and spring migrant populations in the region where the city of Morelia is located, we used January and February temperature and rainfall average values reported for the states that entirely comprise its Mexican wintering (i.e., Oaxaca, Guerrero, Chiapas) and year-round overlapping areas (i.e., Jalisco, Guanajuato, Tlaxcala, Distrito Federal). Temperature and rainfall average values were retrieved from the National Meteorological Service's website (SMN 2009). Although monthly data for temperature by state are available for the entire 13 year period, precipitation data are only available since 2001. We used data from January and February, the two months prior to the arrival of Barn Swallows, to evaluate their effect on the swallow's migration, as greater temperature and rainfall values enhance favorable conditions for this kind of migratory insectivorous birds (Huin & Sparks 1998,

TABLE 1. Linear regression results between average January and February temperature and rainfall from Mexican wintering and year-round areas and the arrival date of Barn Swallows. Due to the availability of data, rainfall regressions only include values for 9 years (2001–2009).

Variable	r^2	*P*
Wintering temperature JAN	0.02	0.63
Wintering temperature FEB	0.08	0.76
Year-round temperature JAN	0.15	0.68
Year-round temperature FEB	0.16	0.68
Wintering rainfall JAN	0.19	0.23
Wintering rainfall FEB	0.47	0.04
Year-round rainfall JAN	0.01	0.98
Year-round rainfall FEB	0.01	0.79

Saino et al. 2004). Thus, we performed linear regressions between January and February temperature and rainfall average values from Mexican wintering and year-round overlapping areas and the arrival day of Barn Swallows to Morelia. Temperature and rainfall values were log-transformed due to non-normal distribution of the data.

RESULTS

Barn Swallows arrived to the city of Morelia from mid-February to mid-March, varying among years (64.5 ± SD 8.4 day elapsed since January 1st). This variation represents an arrival date from March 3–9th in normal years and March 2–8th in leap years. Average rainfall from February at Mexican wintering areas was the only variable that showed a positive and significant relationship with the arrival date of Barn Swallows (Table 1).

DISCUSSION

"The arrival date of a migrant species is the function between the time in which a species departs from a certain location and the time it reaches its destination (Gordo 2007)." Previous studies have found broad and local environmental variables to determine Barn Swallow migratory phenology along its European-African distribution (Huin & Sparks 1998, Gordo & Sanz 2006, Sparks & Tryjanowski 2007, Balbontín *et al.* 2009). Our results show a positive significant relationship between the arrival day of Barn Swallows to the city of Morelia and the amount of rainfall ~ 1 month prior to their arrival. This result is consistent with previous studies that have reported late arrivals with high rainfall values (see Gordo 2007 and references therein). However, our results differ from those reported by others who show that European Barn Swallows respond to changed temperature (Huin & Sparks 1998, Sparks & Tryjanowski 2007), and arrive late in scarce rainfall scenarios (Scheifinger *et al.* 2005). We believe that the arrival date of Barn Swallows in this study, significantly related to February rainfall in its Mexican wintering areas, is associated to the reduction of flying speed and/or progression under unfavorable conditions (Gordo 2007).

Both Mexican average temperature and rainfall in February are negatively related and have shifted in the past decades in Mexico (SMN 2009). While temperature has risen gradually (following the worldwide climate change pattern; Scholze *et al.* 2006), the range of values in rainfall changed after 1970s, with lower minimum values and higher maximum values. Thus, because the Mexican average rainfall in February is related to the Barn Swallow's arrival day in our study area, and arrival dates could influence their breeding success (Møller 1994), higher oscillations in Mexican average rainfall in February could shift Barn Swallow population dynamics in Morelia. However, further research is required to establish possible relationships between the arrival date of Barn Swallows and their primary population parameters (e.g., survival, reproductive success).

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