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Original article

The influence of mistletoes on birds in an agricultural landscape of central Mexico

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ABSTRACT

Mistletoes are hemiparasitic flowering plants that function as keystone resources in forests and woodlands of temperate regions, where a positive relationship between mistletoe density and avian species richness has been observed. Mistletoes have been less studied in tropical regions and the relationship between birds and mistletoes has seldom been explored in tropical agricultural systems. Therefore, we studied the presence of infected trees and infection prevalence (i.e., number of parasitized trees/total number of trees) by *Psittacanthus* (Loranthaceae) mistletoes in 23 hedgerows located in an agricultural landscape of central Mexico during the dry and rainy seasons, and investigated the relationship between bird species richness and abundance and the abundance of mistletoes. We found a mean of 74 mistletoe plants per 100-m transect of only one species, *Psittacanthus calyculatus*. Thirty-one percent of the trees surveyed were infected and tree species differed in infection prevalence, mesquite (*Prosopis laevigata*) being the most infected species with 86% of the surveyed trees infected. For both seasons, we found a positive and significant association between bird species richness and number of mistletoe plants. The same pattern was observed for total bird abundance. Many resident and Neotropical migratory birds were observed foraging on mistletoes. Our results show that mistletoes are important in promoting a higher bird species richness and abundance in tropical agricultural landscapes.

1. Introduction

Mistletoes are a diverse group of hemiparasitic flowering plants that function as keystone resources in many forests and woodlands worldwide (Watson, 2001; Press and Phoenix, 2005). These plants have also been considered ecosystem engineers, having both top-down and bottom-up effects, and generating considerable impact on multiple trophic levels within communities, affecting population dynamics, diversity, and distributions of other plants, invertebrates, birds, and mammals (Press and Phoenix, 2005). Avian pollinators and seed dispersers interact closely with mistletoes, and such associations can be considered truly mutualistic (Press and Phoenix, 2005). Additionally, mistletoe plants are used as a foraging substrate by insectivorous birds, since many insects are associated with mistletoes as both pollinators and herbivores. Mistletoes also provide nesting and roosting sites for birds (Watson, 2001).

Interactions between mistletoes and birds have been studied in many countries, especially in forested regions of Australia, North America, and Europe (Watson, 2001). In most cases, a positive relationship between mistletoe density and avian species richness has been found (Bennetts et al., 1996; reviewed by Watson, 2001, 2002; Mathiasen et al., 2008; Ikin et al., 2014). However, tropical regions are still underrepresented in the mistletoe literature, and it is unclear if mistletoe is as important in structuring these highly diverse ecosystems as in less diverse temperate areas (Watson, 2001).

Psittacanthus mistletoes (Loranthaceae) are shrubby parasites of trees and other woody plants. Seeds are typically dispersed by birds that feed on fruits and later defecate or regurgitate them on branches. After being deposited onto an appropriate host, a seed germinates and forms a haustorium (root structure) that taps into the xylem of the host plant to absorb mainly water and minerals. Once established, the infection is perennial and the mistletoe can develop many branches. Even though these mistletoes photosynthesize, they can interfere with host growth and reproduction when they become too large (Vázquez-Collazo and Geils, 2002). Prevalence and intensity of mistletoe infections usually differ

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among host species. The differential use of hosts by mistletoes may depend on a bird's perching preference, successfulness of seedling establishment, and persistence among host species (Hoffmann et al., 1986; Reid et al., 1995; Roxburgh and Nicolson, 2005). It has also been suggested that tree height may be related to intensity of parasitism (Aukema and Martínez del Río, 2002).

In Latin America, many bird species pollinate *Psittacanthus* flowers and also consume and disperse its fruits, which are large, sweet, conspicuous in color when ripe, and nutritious (Eitniear et al., 1994; Ortiz-Pulido, 1997; López-de Buen and Ornelas, 1999, 2001; Azpeitia and Lara, 2006). The genus *Psittacanthus* has been documented in many forested areas (Watson, 2001; Vázquez-Collazo and Geils, 2002); but, its presence, and the relationship between birds and these mistletoes, has seldom been explored in agricultural systems, where bird resources can be scarce (Atkinson et al., 2004; Vickery et al., 2009). Therefore, we studied the relationship between bird species richness and abundance and the intensity of *Psittacanthus* infection in hedgerows located in an agricultural landscape of central Mexico. We also described the presence of infected trees and the proportion of trees infected by mistletoes, and investigated whether host tree species differed in the intensity of parasitism and whether host tree height was correlated with intensity of parasitism. We expected to find a significant and positive relationship between bird species richness and abundance and mistletoe abundance, for both, Neotropical migratory and resident birds.

2. Materials and methods

2.1. Study area

We studied 23 hedgerows in an agricultural landscape located 10 km north of the City of Celaya in El Bajío, Guanajuato, Mexico (20° 35′N, 100° 50′W; 1750 m asl; Fig. 1). Mean annual temperature is 20.8 °C and mean annual precipitation is 575.3 mm. The presence of infected trees in this area was previously noted during other studies (Zuria and Gates, 2006, 2013; Zuria et al., 2007). This landscape was representative of many agricultural landscapes in Latin America. The main crops are alfalfa (*Medicago sativa*), wheat (*Triticum aestivum*), maize (*Zea mays*), beans (*Phaseolus vulgaris*), and sorghum (*Sorghum vulgare*) (INEGI, 1997). The natural vegetation that remains is called arid tropical scrub (Rzedowski, 1981); it was removed centuries earlier to clear land for agriculture and is currently restricted to the surrounding mountains, some isolated fragments and hedgerows, and scattered trees in the farmland (Rzedowski, 1981; Zuria and Gates, 2006). This vegetation is typically 4–15 m high, and many of the plant species are spiny. The dominant species are mesquite (*Prosopis laevigata*), huizache (e.g., *Acacia farnesiana*, *Acacia schaffneri*), cazahuate or palo bobo (*Ipomea intrapilosa*), and several species of cacti (Rzedowski, 1981).

In our study area, hedgerows are very abundant and surround most cultivated land; their density is highly variable, reaching up to 80 m per hectare (Zuria and Gates, 2006). The most abundant hedgerow trees include pirul (*Schinus molle*), mesquite (*P. laevigata*), avocado (*Persea americana*), and horsetail casuarina (*Casuarina equisetifolia*) (Zuria et al., 2007). They are important to the local people, because they define land ownership; reduce erosion rates, wind flow, and water loss; and provide many plant products (Zuria and Gates, 2006). Hedgerows in the area are also an important habitat for resident and Neotropical migratory birds; 61 bird species have been observed using hedgerows in the area (Zuria and Gates, 2013).

2.2. Study design and habitat description

The study was conducted during both the rainy season (late May–July 2008) and the dry season (December 2008–January 2009). Mean temperature and precipitation during the sampling period were within the average values for the last decade (CIHCG, 2010). We selected 23 hedgerows from an agricultural area of approximately 1600 ha (Fig. 1). Since local- and landscape-scale habitat variables have been shown to influence bird species richness and abundance in vegetated field margins at El Bajío (Zuria and Gates, 2013), and to minimize confounding effects, we selected only hedgerows with similar structural characteristics, i.e., a well-established tree stratum with at least 6 trees in a 100-m transect and immersed in a homogeneous landscape. Selected hedgerows were separated by at least 200 m and were the only hedgerows in that area that met the criteria mentioned above.

A 100-m transect was randomly located at each hedgerow, and we surveyed all trees (woody perennial plants with one main stem or trunk whose diameter at breast height [dbh] was >10 cm) to

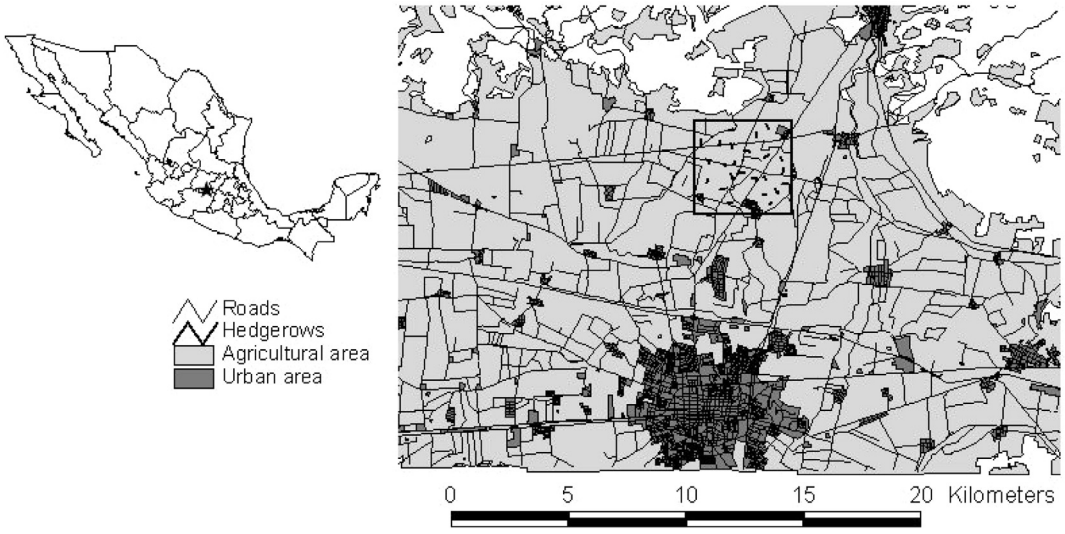

Fig. 1. The study area was located in the State of Guanajuato, Mexico. The black square shows the agricultural landscape where 23 hedgerows were selected for study. White areas on the map represent areas covered with natural vegetation. The large urban area on the bottom is the City of Celaya.