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DYNAMICS OF NECTARIVORY IN THE HOUSE SPARROW IN AN URBAN ENVIRONMENT

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Resumen. – Dinámicas en la nectarivoría de los Gorriones en un ambiente urbano. – En ambientes urbanos, las áreas verdes son usadas a menudo para actividades de recreación por el hombre, las cuales aumentan notablemente durante los fines de semanas, induciendo cambios cíclicos en la actividad de la fauna. Los principales factores en atraer potenciales polinizadores son el número de flores, la cantidad y la calidad del néctar, la densidad y conectividad de las plantas, y las características del hábitat. Sin embargo, dinámicas temporales relacionadas a actividades humanas sobre el nivel de nectarivoría no han sido estudiadas hasta el momento. En este estudio se analiza la variación espacio- temporal de la alimentación de néctar en una población de Gorriones (*Passer domesticus*) sobre una plantación ornamental de *Aloe arborescens* localizada sobre un área recreacional a lo largo de la costa de la ciudad de Mar del Plata (Argentina). Durante los fines de semana se registró un aumento en el tráfico de vehículos y peatones, y una disminución en la cantidad de visitas por parte de los Gorriones a *A. arborescens*. Espacialmente, la cantidad de visitas por los Gorriones fue correlacionada positivamente con la cantidad de inflorescencias durante los días de fin de semana y laborales, pero durante los fines de semana también fue correlacionada negativamente con la distancia entre plantas. Estos resultados sugieren que hay ciclos semanales en los niveles de nectarivoría de los Gorriones, resaltando la importancia de analizar los efectos del disturbio humano en los ambientes urbanos.

Abstract. – In urban environments, the green areas often are used for human recreational activities, which increase notably during weekends, inducing cyclic changes in wildlife activity. Potential pollinators are influenced by the number of flowers, the quantity and quality of nectar, the density and connectivity of plants, and habitat characteristics. However, the temporal dynamics of human activities is also likely to influence visitation rates. In this study, I analyzed the spatial and temporal variation of nectar feeding by a population of House Sparrows (*Passer domesticus*) on a public garden of *Aloe arborescens* plants located on a recreational area along the coast of Mar del Plata City (Argentina). During the weekends there was an increase in vehicle and pedestrian traffic and a decrease in the number of visits by the House Sparrows to *A. arborescens*. Spatially, the number of visits by House Sparrows on *A. arborescens* was positively correlated with the number of inflorescences during both weekend days and working days, but during weekend days also was correlated negatively with the distance between plants. These results suggest that there are weekly cycles in the nectarivory levels of House Sparrows, highlighting the importance of analyzing the effects of human disturbance in urban environments. *Accepted 21 February 2008*.

Key words: Pedestrian and car traffic, opportunistic nectarivory, urban, *Passer domesticus*, *Aloe arborescens*, weekly cycles, feeding behavior.

INTRODUCTION

Movements of humans may induce significant effects on wildlife. Cities and their surrounding areas are characterized by temporal cycles of human movements, which can vary during

the day by the displacement of people from the home to their working places, and during the week by the displacement to the recreational sites in the weekend days. In this context, Bautista *et al.* (2004) found weekly cycles in the activity for certain raptor species in relation to the traffic level, comparing working days with weekend days.

Although the House Sparrow (*Passer domesticus*) is associated with humans, it can be affected negatively by high levels of pedestrians (Fernández-Juricic *et al.* 2001, 2003), although weekly cycles in activity have not been studied.

Opportunistic nectarivory has been reported for several bird species (Franklin 1999, Isacch 2002). Opportunistic nectarivory usually occurs when the nectar is abundant, and especially when preferred resources (insects, seeds) are scarce (Feisinger & Swarm 1992, Franklin 1999). Nectarivory in the House Sparrow has been reported in the literature (Cortés 1982, Vitali-Veiga & Machado 2000, Ortega Olivencia *et al.* 2005). However, few works have analyzed feeding patterns in opportunistic nectarivores (Franklin 1999, Valido *et al.* 2002).

Nectar-feeding species can be influenced by several factors that increase foraging efficiency. The main factor in attracting potential pollinators is the number of flowers (Augspurger 1980, Lorti & Aarseen 1999, Thompson 2001, Valido *et al.* 2002). However, the quantity and quality of nectar (Garrison & Gass 1999, French *et al.* 2005), the density and connectivity of plants (Klinkhamer & Jong 1990), and the habitat structure (Traveset & Sáez 1997, Traveset *et al.* 1998) have also been shown to affect pollinator activity.

In this study I analyze the spatial and temporal factors that are related to the nectar consumption by House Sparrows in a public garden of *Aloe arborescens* along the coast of Mar del Plata City (Argentina). This study was conducted in a recreational area of the city where the flow of vehicles and pedestrians usually increases during weekends by the arrival of tourists and resident citizens.

METHODS

The ornamental *Aloe arborescens* is endemic to South Africa. It flowers in Argentina during the winter (July–September) and grows by parts of the plant; it is the Aloe species most commonly cultivated in the country (Dimitri 1978). The plants in the study area have a basal perimeter of 7–30 m and a height of 0.9–3 m. The flowers are clustered in dense and erect inflorescences. Each inflorescence has a basal diameter of 8–12 cm, and a height of 12–35 cm. Each inflorescence has 27–190 flowers, of which 0–30 are open only at the base of the inflorescence.

The House Sparrow is omnivorous, endemic to Eurasia, and was introduced in Argentina around the year 1870 where since then it has occupied a large portion of the country (Navas 1987). In the study area the species has a mean density of 5 individuals/ 0.5 ha (Leveau & Leveau 2004).

The study was conducted in a public garden of *A. arborescens* located on the coast of Mar del Plata City (38º00´S, 57º34´W; > 500,000 inhabitants). The city has a temperate-oceanic climate, with a mean annual temperature of 14º C, and annual precipitation of 920 mm. The city is surrounded by cultivation, pastures and tree plantations. The *A. arborescens* plants are located in a coastal fringe of 17 ha, on a matrix of managed lawn and scattered trees, surrounded by buildings of more than three stories.

Direct observations of the House Sparrow feeding behavior were made from nine points separated by more than 100 m, during August 2005 and July and August 2006. At each point, I surveyed groups of plants at a distance of 30 m, during counts of 10 min, using 7 x 50 binoculars. The number of plants

TABLE 1. Characteristics corresponding to metric measures of *Aloe arborescens* and the number of trees of the nine points surveyed along the coast of Mar del Plata City.

Variables	Mean	SE	Range
Total number of inflorescences	248.78	229.33	47-646
Total basal perimeter (m)	65.49	54.46	26.20-182.20
Mean height (m)	2.28	0.41	1.50-2.80
Mean distance between plants (m)	20.08	18.57	4.40-63.30
Mean distance to the pathway (m)	8.88	4.18	4.30-15.10
Number of trees	1.89	1.69	0-4

surveyed per point varied between 2 and 8, totaling 33 plants. During each count period, I recorded the cumulative number and sex of the House Sparrows in search of nectar. To avoid pseudoreplication, I observed the direction which the sparrows flew after feeding in the Aloe plants. The sparrows extracted the nectar by perching under the inflorescence and inserting the bill into the perianth, and usually visited more than one inflorescence per plant, and more than one plant per point count. The counts were made during the afternoon, between 14:00 and 16:00 h, during days without rain or strong winds.

At each point, I estimated the total number of inflorescences and the total basal perimeter of all the plants, the mean height, the mean distance to the two nearest plants, the mean distance to the pathway and the total number of trees within a perimeter of 10 m from the plants (Table 1). These variables were correlated with the mean number of sparrows per point count using Pearson correlations, with an alpha value of 0.05. The variables were log-transformed to meet assumptions of normality and homoscedasticity (Zar 1999).

To estimate the degree of human disturbance, during each count of sparrows, I simultaneously counted the number of pedestrians that walked, ran or drove a bicycle by the pathway close to the plants surveyed during the 10 min. On the street next to the pathway, I counted the number of cars and motorcycles that passed by during 1 min. The plants surveyed were at 4–15 m from the pathway, the distance at which the sparrows become alert to an approaching human (Fernández-Juricic *et al.* 2001). To determine the effect of human disturbance on the nectar consumed by the sparrows, 5 surveys per point count were conducted during working days (Monday to Friday), and 5 surveys per point count during weekend days (Saturday and Sunday) or holidays, when human disturbance is greater, totaling 45 counts during each period. For motorcycle and car traffic, I made 31 counts. Because my purpose was to compare the use of the *A. arborescens* plants, and not to calculate absolute densities, I considered the number of birds foraging per point during one survey as independent observations (Meunier *et al.* 2000). A sexual difference in the number of visits was tested using non-parametric Wilcoxon test (Zar 1999). Differences in the number of sparrow visits, pedestrian and vehicle traffic were compared between working days and weekends using non-parametric Mann-Whitney test, with an alpha value of 0.05 (Zar 1999). Sexual differences between weekend days and working days were test using a G-test.

RESULTS

A total of 271 sparrows was counted. The mean number of visits of the sparrows was

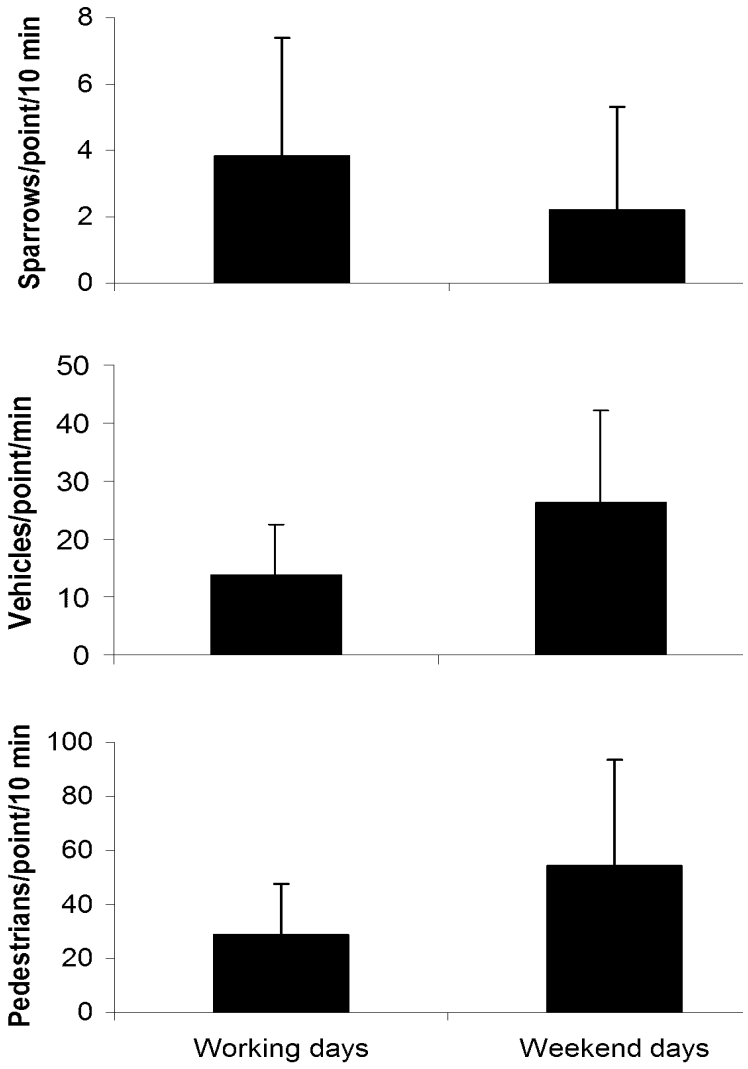

FIG. 1. Mean number of House Sparrow visits to *A. arborescens*, pedestrian and vehicle traffic during working days and weekends. Bars indicate standard deviation.

3.01 ± 3.42 individuals/point/10 min, in a range of 0 to 14 individuals. There were no differences between sexes for the number of visits (males: mean ± SD = 1.33 ± 1.73 individuals/point/10 min; females: 1.68 ± 2.14 individuals/point/10 min, $T = 428.5$, N = 90, $P = 0.10$).

Pedestrian and vehicle traffic were significantly higher during weekend days ($U = 656$, N = 45 for both periods, $P = 0.004$; $U = 243.5$, N = 31 for both periods, $P = 0.001$, respectively; Fig. 1), whereas the level of visits of the sparrows to the plants was significantly lower during the weekend days ($U = 672$, N =

45 for both periods, $P = 0.006$; Fig. 1). There was no difference between sexes in the number of visits on working days and weekend days ($G = 0.64$, df = 1, $P = 0.42$).

Of the independent variables analyzed, the total basal perimeter and the total number of inflorescences were highly correlated ($r = 0.92$, $P < 0.0001$, $N = 9$). As a result, I used the number of inflorescences in analyses. During weekend days, the number of House Sparrows was positively correlated with the number of inflorescences ($r = 0.82$, $P = 0.007$, $N = 9$), and negatively correlated with the mean distance between plants ($r = –0.67$, $P = 0.047$, $N = 9$). During working days, the number of House Sparrows was positively correlated only with the number of inflorescences ($r = 0.91$, $P < 0.001$, $N = 9$). The other metric measures were not significant related to House Sparrow numbers.

DISCUSSION

In this study, the number of visits was correlated with the number of inflorescences. This pattern occurs in both specialist nectarivores (Lorti & Aarseen 1999) and opportunistic nectarivores (Valido *et al.* 2002). Birds that visit the plants with the greater number of inflorescences may maximize their foraging efficiency because they can take more nectar per unit time (Paton 1982). Interestingly, the foraging behavior of the House Sparrows during weekend days also was related to the distance between plants, suggesting that increases in human activity are influencing foraging behavior. Plants that are more clustered may provide greater protection from perceived predators.

Several studies have suggested that high levels of urbanization generate a biotic homogenization, promoted by the invasion of exotic species such as the House Sparrow or the Rock Pigeon (*Columba livia*) (Blair 2001, Clergeau *et al.* 2001). Although the role of the sparrows as pollinators of *A. arborescens* remains to be determined, urban areas also may promote mutualistic interactions between exotic species, which contribute to their successful colonization (see Morales & Aizen 2002).

The results showed that the level of nectarivory in the sparrows had strong differences during the studied period, being significantly lower during weekend days, where the pedestrian and vehicle traffic increase compared to working days. Car traffic noise appears to diminish habitat quality, due to an increase of the stress, and cause distortion in vocal communication (Reijnen & Foppen 1994, Reijnen *et al.* 1997). On other hand, vehicle movement also can disturb the House Sparrows foraging activity.

The risk-disturbance hypothesis predicts that animals, in response to human presence, seek a balance between avoiding disturbance and pursuing activities that may increase fitness, such as foraging, mating and parental care (Frid & Dill 2002). The use of resources by a certain species can be conditioned by the presence of pedestrians, which can be seen as potential predators (Fernández-Juricic & Tellería 2000, Goss Custard *et al.* 2006). An increase in pedestrian levels may promote an increase in the alert state of the sparrows, diminishing their probabilities of feeding.

On other hand, the possibility that the sparrows may have reduced their visitation rate to flowers during the weekend because they were using other temporary resources, such as discarded food from humans is a valid alternative hypothesis.

The patterns found show the importance of considering the effect of pedestrian and vehicle traffic for wildlife conservation in urban environments. Areas with the same habitat structure can have different quality due to human disturbance (Reijnen *et al.* 1997). Although this study was conducted with House Sparrows, which are not strictly

nectarivorous, the results suggest that birds that feed on flowers may be disturbed by human activity. The creation and design of pathways in protected wildlife areas should consider the presence of flowering plants, its use by pollinators and the effect of pedestrians.

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