# Human disturbances and predation on artificial ground nests across an urban gradient

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**Abstract**

*Human disturbances and predation on artificial ground nests across an urban gradient*.— In our study with artificial nests we observed that the absence of ground nesting bird species in the city centre and in residential districts was due to disturbance by humans and domestic animals (dogs and cats) rather than to predation. Furthermore, predation pressure was higher in the outskirts of the city due to the greater number of natural predators. Our results suggest that planning and creating undisturbed areas could increase the chances of ground nesting birds settling and breeding in human–dominated landscapes.

Key words: Disturbances, Nest survival, Plasticine eggs, Quail eggs, Urban development

**Resumen**

*Perturbaciones antropogénicas y depredación en nidos artificiales en el suelo en un gradiente urbano*.— En nuestro estudio con nidos artificiales observamos que la ausencia de especies de aves que nidifican en el suelo en el centro urbano y en barrios residenciales se debía a las molestias causadas por personas y animales domésticos (perros y gatos) y no a la depredación. Además, la presión por depredación fue superior en la periferia de la ciudad debido al mayor número de depredadores naturales. Nuestros resultados sugieren que la planificación y creación de zonas protegidas podrían aumentar la posibilidad de que las aves que nidifican en el suelo se establecieran y se reprodujeran en paisajes dominados por los humanos.

Palabras clave: Perturbaciones, Supervivencia en el nido, Huevos de plastilina, Huevos de codorniz, Desarrollo urbano

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## Introduction

Urbanisation is a strong driver of biodiversity loss because most organisms show poor tolerance to environmental alterations (Sol et al., 2014). Urban bird assemblages are affected by several mechanisms, such as nest predation (Jokimaki & Huhta, 2000). Predator communities and nest predation vary across a gradient of increasing urbanization, but relatively little is known about variation in predation pressure and factors affecting nest survival (Thorington & Bowman, 2003). Several artificial nest studies show that the rate of nest predation is higher in urban environments (*e.g.,* Jokimäki & Huhta, 2000; Thorington & Bowman, 2003; Jokimäki et al., 2005) while others suggest that highly developed urban centres might provide a refuge from predation (Gering & Blair, 1999; Jokimäki et al., 2005). High densities of some 'urban adapter' bird species could partly result from higher nesting success in cities, due to lower numbers of specialist predators and/or lower impact of food–subsidized generalist predators (Gering & Blair, 1999). According to Sol et al. (2014) the loss of species richness in urban habitats is better explained by adaptive differences among species rather than by random processes. Most birds living in the southern Hungarian city of Pécs breed in bushes, trees and buildings, as in other Central–European cities, while ground nesting birds are almost totally absent from the urban area (Luniak, 1990; Bankovics, 2006). Furthermore, the effects of potential nest predators have been studied only on bush nests (Kurucz et al., 2012). Most ground nesting birds are urban avoiders and tend to show lower environmental tolerance (Sol et al., 2014). We hypothesised that they are absent in urban environments due to human disturbance rather than to predation pressure. The aim of our study was to examine the daily survival rate of artificial ground nests in different parts of the city, across an urban gradient. Our objective was to determine the extent of predation in green patches in the city centre, in parks in residential districts, and in near–natural habitats on the outskirts of the city.

## Material and methods

Pécs (46° 06' 58.28'' N, 18° 13' 47.65'' E) is the largest city in Hungary's South–Transdanubian region. Covering 162.61 km$^2$ and having 157,680 residents, Pécs is surrounded from the north by the Mecsek mountains and from the south by the Pécs plain. The climate of influenced by the Mediterranean; the mean annual temperature is 10°C and the mean annual precipitation is 710 mm (Kurucz et al., 2015). According to the European Urban Atlas (European Environment Agency–EEA), the proportion of built–up areas decreases (96%, 48%, 13%) and green areas increase (4%, 52%, 87%) from the city centre towards the outskirts. Considering the rate of built–up areas and land use in the city centre, in the residential district and in the outskirts of the city, we randomly selected 3 × 23 sampling points.

On 20 V 14, we created artificial ground nests in every selected sampling point by digging small depressions in the ground with our boot heel. We did not use any lining material (*e.g.,* feathers, branches, litter, moss, etc.) for the nest. In each artificial nest, we placed one quail egg and one natural coloured plasticine egg of the same size. This imitation eggs were coated with PlastiDip® and had been aired for at least two weeks before the study began (Purger et al., 2012). The nests were then checked on days 1 (21 V), 3 (23 V), 6 (26 V), 10 (30 V) and 15 (4 VI) between 9:00 h and 14:00 h. During nest checking, which lasted no longer than 5 minutes, we recorded the number of cats, and free and leashed dogs observed around the nest to take into consideration the possibility that freely moving domestic animals found and destroyed the eggs in the artificial nests. We calculated nest survival by considering every event (predation, mowing, running over) which had led to damage of any of the eggs. To separate the effects of predation, the daily survival rate of nests was calculated upon predation of quail eggs only. To identify nest predators we used the marks left on the plasticine eggs. The daily survival rate of nests and eggs was calculated by the Mayfield (1975) method and compared using the test proposed by Johnson (1979). We used a 3 × 3 contingency table to compare the proportions of plasticine eggs left intact, removed (missing) or marked by predators (mammals, birds) in three different city sectors . A minimum tail probability of $P < 0.05$ was used for all the statistical tests, and all tests were two–tailed.

## Results

During the survey, 30.4% of the artificial ground nests in the city centre, 21.7% in the residential district and 47.8% in the outskirts were damaged. Daily survival rates of the nests were higher in the centre 0.976 (95% confidence limits: 95.87–99.40) and in the residential district 0.985 (95% c.l.: 97.10–99.83) than in the outskirts 0.959 (95% c.l.: 93.47–98.32), but none of the differences were statistically significant (table 1). When we considered all events that had caused damage or destruction in the 23 ground nests (quail eggs and/or plasticine eggs were damaged in 18 nests, four nests were destroyed during mowing in the residential district, and one nest was tread on in the centre), we concluded that the daily survival rate of ground nests was high in all city sectors (table 1).

When we analysed predation on quail eggs only ($n$ = 16), the survival rates of eggs (fig. 1) in the centre 0.987 (95% c.l.: 97.40–99.99) and in the residential district 0.997 (95% c.l.: 99.07–100.31) were significantly higher than in the outskirts 0.960 (95% c.l.: 93.66–98.37) (table 1).

In the city centre three quail eggs disappeared from nests and one was broken ($n$ = 4). Five unleashed dogs were observed in this city sector ($n$ = 5). Four plasticine eggs disappeared, two were damaged by small birds, and one was damaged by small mammals ($n$ = 7).

Table 1. Comparison of daily survival rates of nests. All adverse events were taken into account but only damage to quail eggs was considered a predation event.

*Tabla 1. Comparación de los índices diarios de supervivencia en el nido. Se tuvieron en cuenta todos los efectos adversos, pero solo se consideraron actos de depredación los daños causados en los huevos de codorniz.*

| | | All adverse events (n = 23) | | Predation of quail eggs (n = 16) | |
|---|---|---|---|---|---|
| | | Z–value | *P* | Z–value | *P* |
| City centre | Residential district | 0.743 | 0.458 | 1.382 | 0.167 |
| Residential district | Outskirts | 1.847 | 0.065 | 3.017 | 0.003** |
| City centre | Outskirts | 1.160 | 0.246 | 1.997 | 0.046* |

The survival rates of eggs were high in the residential district, despite the high number of cats (*n* = 3) and dogs (*n* = 32 leashed, *n* = 10 unleashed) observed. During almost every checking we observed rooks *Corvus frugilegus* and jackdaws *Corvus monedula* searching for food on the ground. Only in one nest was a quail egg broken (fig. 2), probably by a small bird whose marks were left on the plasticine egg (fig. 2).

The highest predation rate was recorded for nests located in the outskirts of the city. During nest checking, a cat was seen on one occasion and no dogs were observed in this area. Quail eggs disappeared from seven nests and in four nests we found them broken (*n* = 11). Two of twenty–three plasticine eggs disappeared, four were found to have small mammal bite marks (fig. 2), and two showed beak marks left by small birds (*n* = 8).

The number of plasticine eggs left intact, taken away, or marked by predators indicates that the impact of egg predators was small, with only marginal differences ($\chi^2$ = 9.423, df = 4, *P* = 0.051) between the three city sectors (fig. 3).

## Discussion

The results of our study on human disturbances and predation on artificial ground nests across an urban gradient suggest that nest survival is higher in built–in areas such as the city centre and residential districts than in the outskirts. Moreover, if we considered only predation of quail eggs and ignored damage caused by mowing and running over, the differences between

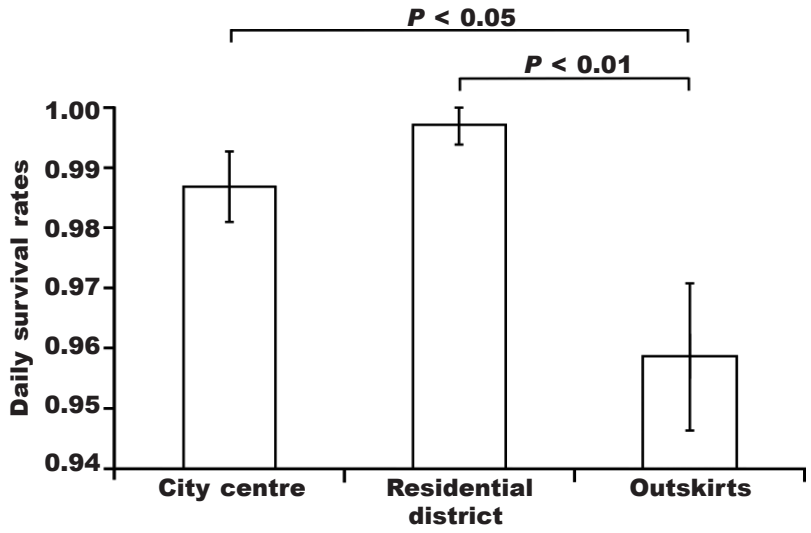


Fig. 1. Daily survival rates of quail eggs (± SE) in artificial ground nests located in three different sectors of Pécs.

*Fig. 1. Índices diarios de supervivencia de los huevos de codorniz (± DE) en nidos artificiales en el suelo situados en tres sectores diferentes de Pécs.*


Fig. 2. A. Coated plasticine eggs with bill imprint (pecking) of small–bodied birds; B. Coated plasticine eggs with tooth imprint (gnawing) of small mammals; C. Broken quail egg.

*Fig. 2. A. Huevos recubiertos de plastilina con marcas de picotazos de aves de pequeño tamaño; B. Huevos recubiertos de plastilina con marcas de roeduras de pequeños mamíferos; C. Huevo de codorniz roto.*

sectors were statistically significant. Our results suggest that predation is low. Ground nesting crested larks *Galerida cristata* sporadically occurred in residential districts, but their breeding was not verified. In many cities instead of breeding on the ground in green areas they breed on flat roofs of buildings (Orbán, 2004). According to our previous observations, crested larks breed only in the outskirts and near parking plots of supermarkets, and in low numbers. Corn bunting *Miliaria calandra*, yellowhammer *Emberiza citrinella*, European nightjar *Caprimulgus europaeus*, common quail *Coturnix coturnix* and common pheasant *Phasianus colchicus* sporadically breed in near–natural habitats in the surroundings of the city (Bankovics, 2006). In the city centre and residential districts predation on artificial ground nests was lower, but the effects of increased human presence (damage caused by trampling, mowing) were stronger. Previous surveys

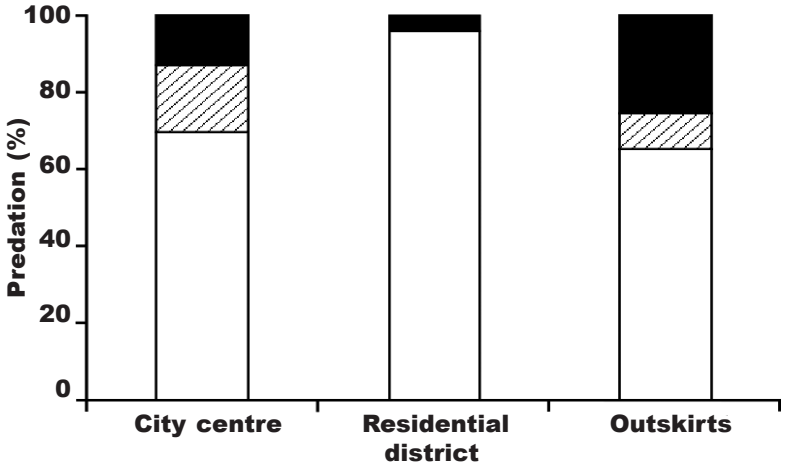


Fig. 3. Rate of predation of plasticine eggs in ground nests in three different city sectors: eggs found intact (white bars), eggs taken away (hatched bars), and eggs marked by predators (black bars).

*Fig. 3. Índice de depredación de los huevos de plastilina en nidos en el suelo en tres diferentes sectores de la ciudad: huevos encontrados intactos (barras blancas), huevos extraídos (barras rayadas) y huevos con marcas de depredadores (barras negras).*

(*e.g.,* Gering & Blair, 1999) have shown that growing urbanisation results in decreasing nest predation. In the outskirts of the city, however, our results showed that the survival of artificial ground nests was mainly influenced by predation.

Urban environments favour high numbers of generalist predators (Jokimaki & Huhta, 2000; Chace & Walsh, 2006). Species of the *Corvidae* family are associated with urban areas, but their responses to urbanisation vary greatly (Sorace & Gustin, 2009). Despite the frequent presence of rooks and jackdaws, we did not observe any predation activity, although many eggs disappeared from the nests. Our previous studies showed that hooded crows *Corvus cornix* and Eurasian jays *Garrulus glandarius* were responsible for nest predation in the city and surrounding areas. Mammal predators like red foxes *Vulpes vulpes*, beech martens *Martes foina* and northern white–breasted hedgehogs *Erinaceus roumanicus* are frequently observed, but we could not demonstrate their role in ground nest predation.

The absence of ground nesting bird species at our study site is not due to predation but to disturbance by humans and domestic animals (dogs and cats) in built–up areas. In the future we could provide a chance for ground nesting birds to settle and breed in human–dominated landscapes by planning and creating undisturbed areas, taking advantage of the scarecrow effect created by human presence that keeps predators away.

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