

武汉市城乡乌鸫的巢址选择

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摘要: 为了探讨乌鸫 (*Turdus mandarinus*) 在城市与村庄的巢址选择差异, 在武汉市城乡对乌鸫的 14 个巢址参数和 4 个巢特征参数进行了对比研究。对城市和村庄乌鸫的 14 个巢址参数进行主成分分析发现, 特征值大于 1 的主成分共有 5 个, 累计贡献率达 69.040%, 巢址特征主要受巢树因子 (胸径、树冠直径、距最近树的距离和树高)、巢位置因子 (巢距离树冠底部的距离、巢高和巢位)、干扰因子 (距离最近路的距离)、隐蔽性因子 (巢上方的盖度) 和食物因子 (距离最近农田的距离) 的影响。城市和村庄乌鸫的巢特征参数均无显著差异。乌鸫城市巢的距树和距农田距离显著大于村庄巢所对应的参数, 且城市乌鸫巢的树高、胸径和盖度也均显著大于村庄巢的对应参数。城市乌鸫偏好在香樟 (*Cinnamomum camphora*) 上筑巢, 而村庄乌鸫的筑巢树种更为多样; 城市乌鸫偏好在更为高大、粗壮和隐蔽性更强的树上筑巢。本研究表明, 城市化会导致乌鸫的巢址选择发生变化, 乌鸫能够根据生活环境的不同调整巢址选择策略。

关键词: 乌鸫; 城市化; 巢址选择

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Nest site selection of *Turdus mandarinus* in urban and rural environments of Wuhan, China

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Abstract: [Objectives] Reproduction is a critical phase in the life history of birds, with the selection of an appropriate nest site being paramount to reproductive success. This selection is influenced by a multitude of environmental factors. Accelerated urbanization leads to habitat fragmentation and compression of avian living spaces, compelling birds to adapt swiftly. The impacts of urbanization on birds are multifaceted, resulting in differences in nest site selection and other aspects compared with their rural counterparts. Therefore, investigating the nest site selection of Chinese Blackbirds (*Turdus mandarinus*) in urban and rural settings is of great importance and necessity, contributing to our understanding of how birds adapt to urbanized environments. **[Methods]** From May to August 2024 and April to May 2025, we conducted

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systematic surveys for Chinese Blackbird nests in Huangpi District, Wuhan City, Hubei Province. Nests were surveyed bi-weekly. Upon nest discovery, the internal conditions were recorded, and each nest was sequentially numbered and located in the order of discovery. Following the conclusion of the breeding season, nest characteristic parameters, including inner diameter, outer diameter, cup depth, and nest depth, were measured via a fine measuring tape. Nest site parameters were measured via a measuring tape, while distances beyond the range of the tape were measured via ArcGIS software. A total of 14 nest site parameters related to the reproduction of Chinese Blackbirds were recorded. **[Results]** During the study period, we recorded the nest characteristic parameters of 62 Chinese Blackbird nests (21 urban nests and 41 rural nests) and 14 nest site parameters of 128 Chinese Blackbird nests (49 urban and 79 rural nests). There were no significant differences in the nest characteristic parameters between urban and rural nests. The distances from nests to trees and farmlands were significantly further for urban nests than for their rural counterparts, and tree height, diameter at breast height, and coverage above the nest were significantly greater for urban nests than for rural nests. Urban Chinese Blackbirds showed a preference for nesting in Camphor Trees (*Cinnamomum camphora*), whereas rural Chinese Blackbirds nested in a wider variety of tree species. Urban Chinese Blackbirds preferred to nest in taller, more robust trees with better concealment (Table 3). **[Conclusion]** This study demonstrates that predator avoidance is the primary factor influencing nest site selection for Chinese Blackbirds. Urban Chinese Blackbirds exhibit a preference for taller and more concealed tree canopies to evade predators, particularly feral cats. Foraging considerations also play a crucial role. Rural Chinese Blackbirds tend to nest near farmlands and woodlands, while their urban counterparts rely on green spaces such as parks and urban forests. Urbanization influences nest preferences, leading to a propensity for specific tree species and taller trees. The adaptability of Chinese Blackbirds to urban environments is evident, as exemplified by instances of nesting on utility poles. Future research will delve into the adaptive changes of Chinese Blackbirds across varying degrees of urbanization, thereby contributing theoretical insights to support urban ecological conservation and avian research.

Key words: Chinese Blackbird; Urbanization; Nest site selection

繁殖是鸟类生活史的最重要阶段之一，为确保最大的繁殖产出，鸟类已经演化出一系列与环境密切相关的繁殖策略 (Badyaev 1995)。如在繁殖开始前，选择合适的巢址对繁殖至关重要，它会直接关系巢的安全程度，影响鸟类繁殖成功率 (丁长青和郑光美 1997, 杨君林等 2024)。鸟类的巢址选择不是单独由某个特定因素决定的，而是综合了食物、人为干扰和隐蔽度等多种因素共同的结果 (Clark and Shutler 1999, Millones and Frere 2018, 王心蕊等 2024)。

近几年，随着城市化 (urbanization) 进程的加快造成动物的栖息地破碎化，城市鸟类的

生存空间受到了严重挤压，迫使一些鸟类改变生存策略来适应城市化环境，以更好地在城市环境中生存 (杨刚等 2015, 贺萌等 2020, Kucherenko and Ivanovskaya 2020, Hiemstra et al. 2023)。有研究表明，城市化对鸟类的影响是多元化的，一些适应了城市环境的鸟类，与农村鸟类在巢址选择、食谱甚至遗传特征方面都产生了差异 (Marzluff 2001, Mohring et al. 2021, Patankar et al. 2021)。此外，城市化常常会导致人为干扰增多、光污染、噪声污染和化学污染的增强 (Cabrera-Cruz et al. 2019, James Reynolds et al. 2019, Brancaccio-Perez et al.

2024)。也有研究表明,城市为鸟类提供的大量筑巢场所很多是生态陷阱(ecological traps)

(Ben-Aharon et al. 2020),如一些巢结构较为简单的鸟类(如鸽形目鸟类)常在阳台等距离人很近的地方筑巢,其巢会经常被人破坏(Schlaepfer et al. 2002,张琴等 2013)。虽然城市鸟类相比自然栖息地中的鸟类会受到更多的人为影响,但是城市化也为很多鸟类的生存提供了新的机会(卢向东等 2024)。城市的热岛效应可能会导致植物提前生长,能为鸟类更早地提供巢址资源,使得城市中的鸟类能够更早开始筑巢(赖小红等 2019)。鸟类在城市环境中可以获得更多的筑巢材料,如自然栖息地中没有的人工巢材用来筑巢(Mainwaring 2015,李翔等 2019,Chen et al. 2024),使得城市生活的鸟类获得了更多资源的同时,可以缩短筑巢期,节省能量用于养育后代(Crates et al. 2016)。

乌鸫(*Turdus mandarinus*)隶属于雀形目(Passeriformes)鸫科(Turdidae)(郑光美 2023),在我国共有 4 个亚种,是一种社会性单配制鸟类(朱超英 2019,阎雪玉和米玛旺堆 2023)。乌鸫作为城市中最常见的鸟类之一,是研究鸟类栖息地环境、巢址选择、婚配制度等的理想实验模型(周立志等 2001,罗骏等 2008,徐玉梅 2009,Evans et al. 2010,黄族豪等 2011,路文静 2021)。武汉作为我国中部地区重要城市,城市化程度高,其城市化进程对鸟类繁殖的影响仍不明了,本研究选择在武汉城市和村庄地区进行研究,对乌鸫巢址选择因素进行更为详细的量化,探讨城市化对乌鸫巢址选择的具体影响,这将有助于加深人们对鸟类繁殖如何响应城市化的认识。

1 研究区域与研究方法

1.1 研究区域

湖北省武汉市黄陂区(114°09'~114°37'E,30°40'~31°22'N)北依大别山南麓,南临长江,整个地势北高南低,自北向南逐渐倾斜。黄陂

区属亚热带季风气候,雨量充沛、光照充足,热量丰富,四季分明,年平均无霜期 255 d。境内平均气温为 15.7~16.4℃,年均降水量在 1 000~1 200 mm 之间,雨量分布的时空差异较大,洪涝干旱时有发生(中国天气网 2024)。

使用 ArcGIS 10.8 软件,以城市和村庄区域的鸟巢为中心建立半径为 1 km 的圆形缓冲区,计算缓冲区内的人造地表面积占比,当人造地表覆盖率不低于 50%,定义为城市地区,人造地表覆盖率低于 50%为村庄地区(Peng et al. 2024)。其中,城市地区的生境主要是城市公园、道路硬地、人工绿化带和居民区,这些区域的主要干扰是人类活动和车辆噪声,人为干扰较多,环境较为喧嚣,植被类型主要为香樟(*Cinnamomum camphora*)等行道树种,较为单一;村庄地区主要是村落(李三湾、张家岗、合丰村等 87 个村庄),这些区域的生境是以村落和次生林为主,主要干扰是人为耕作,环境幽雅恬静,在村庄的附近有农田和池塘,鸟类和植被的种类较为丰富(图 1)。

1.2 调查方法

在鸟类繁殖季(2024 年 5 至 8 月和 2025 年 4 及 5 月)对研究区域进行地毯式搜查,寻找乌鸫的巢。乌鸫常利用枯草和泥土筑巢,且大多巢筑于乔木主干上。于鸟类繁殖季,在研究区域内每隔一周进行一次摸排找巢,发现巢后记录巢内情况,按照发现顺序依次编号并定位,待繁殖结束后用细卷尺(迷你小卷尺,河南邦特工量具有限公司,量程 0~1 m,精度 0.1 cm)测量巢特征参数,包括巢的内径、外径、杯深和巢深,巢址参数用卷尺(皮卷尺,河南邦特工量具有限公司,量程 0~30 m,精度 1 cm)测量,距离超过卷尺测量范围的参数使用 ArcGIS 10.8 软件测量。共测量了 14 个巢址参数。

(1) 树种:巢树的种类;

(2) 树高:巢树的高度;

(3) 胸径:巢树距离地面 1.5 m 处树干的直径;

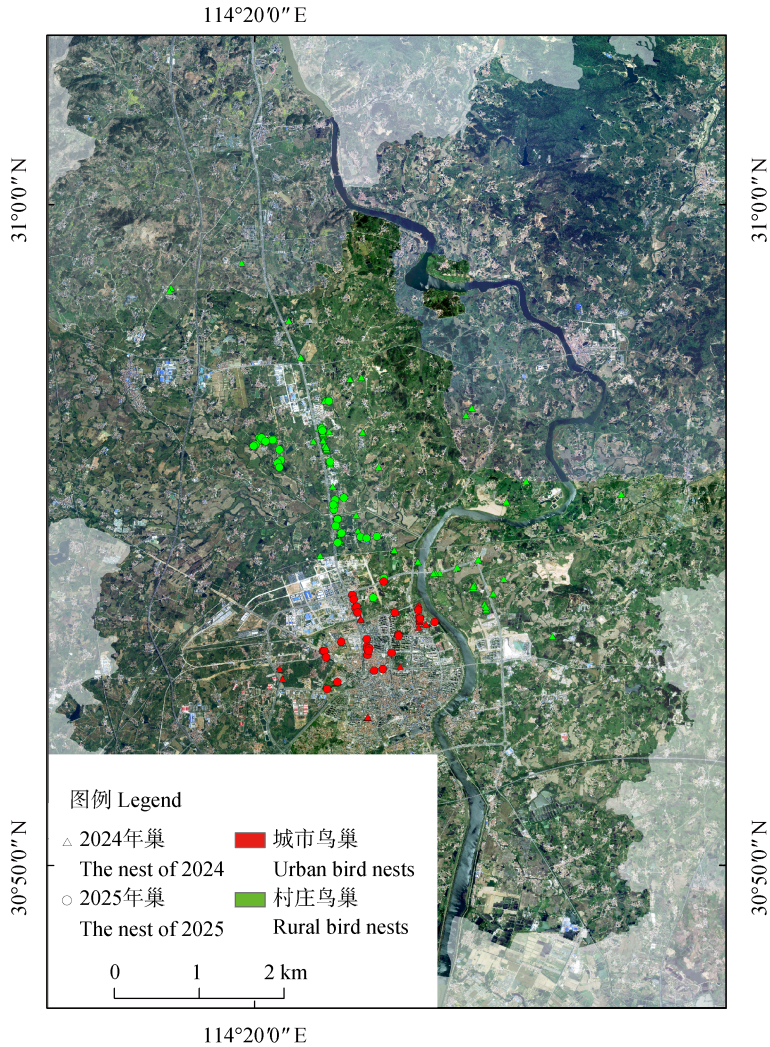


图 1 研究区域及其乌鸫巢的分布

Fig. 1 Study area and nest distribution of Chinese Blackbirds (*Turdus mandarinus*)

基于审图号 GS (2024) 0568 的标准地图制作, 底图未作修改。

Based on the standard map with the review number GS (2024)0568, no modifications have been made to the base map.

(4) 树冠直径: 树冠过树干的直线水平距离;

(5) 郁闭度: 巢树树冠垂直投影面积占其正下方地表总面积的百分比;

(6) 距路: 距离最近路的距离;

(7) 距建筑物: 距离最近建筑物的距离;

(8) 距农田: 距离最近农田的距离;

(9) 距水源: 距离最近水源 (面积不低于 25 m²) 的距离;

(10) 距树: 巢树距离最近树的水平距离;

(11) 巢高: 鸟巢距离地面的垂直高度;

(12) 巢-冠底: 鸟巢距离树冠最下缘的垂直距离;

(13) 盖度: 指巢上方植被垂直投影面积占巢口总面积的百分比;

(14) 巢位: 巢所在的位置在主枝处记录为 1, 在二级分枝记录为 2, 在三级分枝记录为 3, 依此类推。

1.3 数据分析

使用 SPSS 27.0 统计软件分析数据, 采用

Kolmogorov-Smirnov 检验对数据进行正态分布检验, 数据符合正态分布使用独立样本 t 检验, 数据不符合正态分布, 则使用 2 个独立样本的 Mann-Whitney U 检验进行比较。通过主成分分析 (principal component analysis, PCA) 对测量的所有巢址参数进行降维处理, 探究乌鸫巢址参数中的主导因素。定量、变量的描述性统计值采用平均值 \pm 标准差, $P < 0.05$ 差异显著, $P < 0.01$ 差异极显著。

2 结果

2.1 巢特征参数

共测量 62 个乌鸫巢的巢特征参数, 其巢呈碗状, 巢材主要由泥土和枯草茎组合, 雏鸟离巢后鸟巢干枯易破碎。对城市和村庄乌鸫的 4 个巢特征参数进行差异性特征分析, 发现城市和村庄乌鸫的 4 个巢特征均无显著差异 ($P > 0.05$) (表 1)。

2.2 巢址参数的主成分分析

为确定影响乌鸫巢址选择的主要因子, 对 128 个乌鸫巢的 14 个巢址参数进行主成分分析, 有 5 个主成分的特征值大于 1, 累计贡献率达 69.040%, 表明这 5 个主成分包含了 14 个巢址因子的绝大部分信息量。提取前 5 个主成分并计算出每个参数所对应的特征向量 (表 2)。

第一主成分特征值为 4.014, 贡献率达到 28.674%, 其中载荷系数绝对值较大的有: 胸径 (0.775)、树冠直径 (0.770)、距树 (0.758)

和树高 (0.731), 反映出巢树的结构特征对乌鸫筑巢的影响, 命名为巢树因子。第二主成分特征值为 1.840, 贡献率达到 13.142%, 其中, 载荷系数绝对值较大的有: 巢-冠底 (0.865)、巢高 (0.809) 和巢位 (0.715), 这与巢在巢树树冠中的位置相关, 命名为巢位置因子。第三主成分特征值为 1.562, 贡献率达 11.154%, 其中, 载荷系数绝对值较大的为距路 (0.802), 反映出道路车辆和行人的干扰对乌鸫筑巢的影响, 命名为干扰因子。第四主成分特征值为 1.190, 贡献率达到 8.499%, 其中, 载荷系数绝对值较大的为盖度 (0.829), 反映出巢的隐蔽性对乌鸫筑巢的影响, 命名为隐蔽性因子。第五主成分特征值为 1.060, 贡献率达到 7.571%, 其中载荷系数绝对值较大的为距农田 (0.909), 反映出食物对乌鸫筑巢的影响, 命名为食物因子。

2.3 巢址选择的分化

对乌鸫城市和村庄巢的巢址参数进行比较 (表 3), 乌鸫在城市和村庄的巢树选择存在显著差异。在城市中, 乌鸫倾向于选择香樟和梧桐 (*Firmiana simplex*) 等少数几种树种筑巢, 而在村庄, 其巢树选择则表现出更高的多样性; 城市乌鸫巢的树高显著高于村庄; 城市乌鸫巢树的胸径也显著比村庄巢树粗; 村庄乌鸫的巢距离食物来源的距离显著比城市近; 城市中巢树与最近树的距离显著远于村庄; 在鸟巢隐蔽度方面, 城市的鸟巢盖度显著高于村庄。

表 1 城市和村庄乌鸫巢特征参数分析

Table 1 Nest characteristic parameters of Chinese Blackbirds (*Turdus mandarinus*) in urban and rural areas of Wuhan

	巢内径 Inner diameter (cm)	巢外径 Outer diameter (cm)	杯深 Cup depth (cm)	巢深 Nest depth (cm)
城市 Urban area ($n = 21$)	11.690 \pm 2.032	17.810 \pm 2.957	7.638 \pm 1.131	14.552 \pm 3.259
村庄 Rural area ($n = 41$)	11.646 \pm 1.015	17.508 \pm 1.473	7.880 \pm 1.177	14.301 \pm 2.707
Z	-0.127	-0.409	-0.849	-0.335
P	0.899	0.682	0.396	0.738

表 2 乌鸫巢址选择参数中特征向量的转置矩阵

Table 2 Rotated eigenvector matrix of nest site selection of Chinese Blackbirds (*Turdus mandarinus*)

变量 Variable	主成分 Principal component				
	1	2	3	4	5
树种 Tree species	-0.171	0.137	0.314	-0.621	0.158
树高 Nest tree height	0.731	0.417	-0.210	0.014	0.089
胸径 Diameter at breast height	0.775	0.363	-0.217	0.063	0.097
树冠直径 Tree crown diameter	0.770	0.397	-0.201	0.049	0.085
郁闭度 Nest tree canopy density	0.102	0.002	0.044	0.672	0.132
距路 Distance to the nearest road	0.059	-0.023	0.802	0.014	-0.349
距建筑物 Distance to the nearest building	-0.265	-0.219	0.578	0.005	0.091
距农田 Distance to the nearest farmland	0.110	0.050	0.030	0.072	0.909
距水源 Distance to the nearest water	-0.181	0.116	0.689	0.015	0.350
距树 Distance to the nearest tree	0.758	-0.317	0.062	0.057	-0.081
巢高 Nest height	0.391	0.809	0.012	-0.041	0.187
巢-冠底 Distance of nest from the crown bottom	0.134	0.865	-0.044	0.060	-0.038
盖度 Coverage above the nest	-0.132	0.047	0.146	0.829	0.030
巢位 Nest position	0.010	0.715	-0.028	-0.073	0.012
特征值 Eigenvalue	4.014	1.840	1.562	1.190	1.060
贡献率 Variance explained (%)	28.674	13.142	11.154	8.499	7.571
累计贡献率 Cumulative variance explained (%)	28.674	41.816	52.971	61.469	69.040

3 讨论

鸟类的巢址选择会随着环境的不同发生变化,巢址的质量也会影响繁殖成功与否 (Millones and Frere 2018)。为了避开天敌捕食、人为干扰等不利于繁殖的因素,鸟类往往会将巢建立在合适的巢位点上来确保繁殖成功率 (Frommhold et al. 2019)。

本研究表明,在城市繁殖与在村庄中繁殖的乌鸫巢特征参数无显著差异。在其他鸟类研究中也发现了类似的结果,如喜鹊 (*Pica serica*) 在城市中巢特征的变化相对较小 (Wang et al. 2008),而欧亚大山雀 (*Parus major*) 或蓝山雀 (*Cyanistes caeruleus*) 的巢大小和重量在不同城市化程度的地区无显著差异 (Glądalski et al. 2016, Lambrechts et al. 2017)。乌鸫的巢材选

择可能是导致城乡乌鸫的巢大小无差异的原因之一,目前尚未发现乌鸫利用人工材料筑巢,乌鸫巢外侧为泥土和枯草叶的混合物,巢内衬为编织在一起的较为柔软的枯草根,这两种材料无论在村庄农田还是城市公园都比较常见。因此,城市化对乌鸫巢特征的影响可能是有限的。

乌鸫筑巢首先考虑的是巢树特征、巢位置、隐蔽度和人为干扰这些与鸟巢安全性有关的因素。无论在城市还是自然环境中,安全性都是鸟类选择巢址的关键因素 (罗骏等 2008, 施丽敏等 2012, 孟晓静等 2014, 阎雪玉和米玛旺堆 2023)。隐蔽假说认为,鸟类偏爱在枝叶繁茂的环境中筑巢 (Schmidt 1999)。例如,在圆明园繁殖的一些鸟类喜欢在高大的树木上筑巢 (赵鸿宇 2019),因为高大的树木往往可以提

表 3 城市和村庄乌鸫巢址参数比较

Table 3 Comparison of nest site parameters of Chinese Blackbirds (*Turdus mandarinus*) between urban and rural areas

变量 Variable	城市 Urban area (n = 49)	村庄 Rural area (n = 79)	Z 值 Z-value	P 值 P-value
树种 Tree species*	1.670 ± 1.886	2.430 ± 2.330	-2.231	0.026
树高 Nest tree height (m)	9.969 ± 2.858	9.249 ± 2.799	-2.107	0.035
胸径 Diameter at breast height (cm)	31.016 ± 11.870	26.147 ± 11.061	-2.782	0.005
树冠直径 Tree crown diameter (m)	6.124 ± 2.990	5.614 ± 2.653	-1.015	0.310
郁闭度 Nest tree canopy density (%)	74.350 ± 17.208	73.690 ± 16.177	-0.585	0.559
距路 Distance to the nearest road (m)	11.140 ± 18.718	16.133 ± 28.825	-1.582	0.114
距建筑物 Distance to the nearest building (m)	119.450 ± 143.681	127.670 ± 142.809	-0.296	0.767
距农田 Distance to the nearest farmland (m)	274.880 ± 186.984	94.450 ± 96.731	-5.645	< 0.001
距水源 Distance to the nearest water (m)	335.040 ± 311.567	348.93 ± 401.526	-0.771	0.441
距树 Distance to the nearest tree (m)	4.663 ± 1.872	3.835 ± 1.737	-3.095	0.002
巢高 Nest height (m)	5.308 ± 1.685	4.850 ± 1.687	-1.894	0.058
巢-冠底 Distance of nest from the crown bottom (m)	2.004 ± 1.446	2.409 ± 1.488	-1.536	0.125
盖度 Coverage above the nest (%)	72.240 ± 20.793	64.110 ± 22.400	-2.278	0.023
巢位 Nest position	1.840 ± 0.800	2.100 ± 0.891	-1.687	0.092

* 村庄树种包括香樟、梧桐、五角槭、榉树、楝、栾树、槐树、胡桃和白花泡桐；城市树种包括香樟、梧桐、栾树和槐树，以及电线杆。

* Village tree species include *Cinnamomum camphora*, *Firmiana simplex*, *Acer pictum*, *Zelkova serrata*, *Melia azedarach*, *Koelreuteria paniculata*, *Styphnolobium japonicum*, *Juglans regia* and *Paulownia fortunei*; Urban tree species include *C. camphora*, *F. simplex*, *K. paniculata*, *S. japonicum*, and utility pole.

供更好的隐蔽度。城市乌鸫选择的巢树比村庄乌鸫的更为高大，隐蔽性也更好。虽然城市乌鸫的巢高高于村庄乌鸫的巢高，但两者并无统计学差异。这可能和城市分布着大量的流浪猫有关，流浪猫的捕食作用会导致城市鸟类将巢筑在高处来躲避捕食者 (Rendell and Robertson 1989, Sims et al. 2008, Li et al. 2021)。在武汉市城区中，乌鸫主要在香樟上筑巢，在村庄乌鸫筑巢的树种更为多样。这可能和城市化过程中乡土树种被移除，仅保留一些适合绿化的树种有关 (Narango et al. 2017)。在城市地区乌鸫还会在电线杆上筑巢，表明在营巢环境中人为干扰过强或者没有合适筑巢树种时乌鸫也会将人类建筑物作为营巢地点 (Wang et al. 2015)。

其次，乌鸫在进行巢址选择时食物因素也至关重要，村庄乌鸫距离农田和最近树更近，意味着村庄乌鸫能够更直接获得食物资源。乌

鸫是杂食性鸟类，食物来源主要包括蚯蚓、昆虫、植物种子和浆果。尽管城市中乌鸫距农田和最近树的距离较远，但它们与城市公园绿地和绿化带的距离较近，这些地方同样可以成为乌鸫的食物来源 (黄越 2015)。城市的热岛效应会使城市中的物候提前，食虫鸟类能够更早获得食物资源 (Vaugoyeau et al. 2016, Parece et al. 2018)。

总之，本研究表明，城市化会对乌鸫的巢址选择产生影响，导致城乡乌鸫的巢址选择发生变化。接下来的研究中，将结合城市化程度不同的地区进行再区分，并对每个地区的乌鸫巢址选择进行对比研究，以探讨乌鸫在不同城市化环境中的适应性变化。通过对乌鸫生态需求的深入理解，我们将为城市生态环境保护和鸟类研究提供理论基础，从而促进人与自然的和谐共生。

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