aci avances en ciencias e ingenierías

Comunicación / Communication
Sección B/Section B
Vol. 16, nro. 1
e3169

On the use of anthropogenic materials in nest building of House Wren (*Troglodytes aedon*), a report from Parque Los Algarrobos, Cumbayá, Ecuador

Roberto J. León-E.[1], Ariel Guerrero-Campoverde[1], Mateo Dávila-Játiva[1*]

[1] Universidad San Francisco de Quito USFQ, Colegio de Ciencias Biológicas y Ambientales COCIBA, Instituto de Biodiversidad Tropical IBIOTROP, Laboratorio de Zoología Terrestre, Museo de Zoología, Quito 170901, Ecuador

*Corresponding author: teodavila@gmail.com

El uso de material antropogénico en la construcción de nidos del Sotorrey Común (*Troglodytes aedon*), un reporte desde el Parque Los Algarrobos, Cumbayá, Ecuador

Resumen

Los nidos, estructuras críticas para el desarrollo de algunos vertebrados, son construidos de diversos materiales con efectos variables en aislamiento, propiedades antimicrobianas, conspicuidad y atracción de pareja. Los entornos antropogénicos, consecuencia del aumento de la población humana, impactan en los ecosistemas nativos, llevando a muchas especies de aves a incorporar materiales de construcción de origen antropogénico en sus nidos. Sin embargo, tales comportamientos rara vez se reportan en aves pequeñas terrestres. Este artículo describe la observación de un Soterrey (*Troglodytes aedon*) en un entorno urbano ecuatoriano, transportando plástico transparente para la construcción de su nido en una farola. Además discutimos la interacción de factores que podrían explicar este comportamiento novedoso. Esta visión del comportamiento de construcción de nidos aviares en entornos urbanos destaca la necesidad de estudios adicionales para desentrañar mecanismos adaptativos en medio de cambios ambientales y crecimiento poblacional.

Palabras clave: Bolsa de plástico, Impacto humano, Nidos, Sotorrey, Urbanización

Abstract

Nests, critical structures for vertebrate development, exhibit diverse materials with varying effects on insulation, antimicrobial properties, concealment, and mate attraction. Anthropogenic environments, a consequence of increasing human populations, impact native ecosystems, leading many bird species to incorporate anthropogenic nest materials. However, such behaviors are seldom reported in small land birds. This article presents a unique observation of a House Wren (*Troglodytes aedon*) in an Ecuadorian urban setting, carrying transparent plastic for nest-building in a streetlamp. We discuss the interplay of factors that might explain this novel behavior. This insight into avian nest-building behavior in urban environments underscores the need for further studies to unravel adaptive mechanisms amid environmental changes and population growth.

Keywords: Human impacts, Nest, Plastic bag, Urbanization, Wren

Editado por / Edited by: Elisa Bonaccorso

Recibido / Received: 30/11/2023

Aceptado / Accepted: 29/12/2023

Publicado en línea / Published online: 30/04/2024

DOI: https://doi.org/10.18272/aci.v16i1.3169

Nests are structures built by a variety of vertebrates and often control the conditions where offspring develop [1,2,3]. Nesting materials often vary but can cause differing effects based on the emerging properties of the material. Such effects can change the nest's insulation, antimicrobial and antiparasitic properties, concealment, and even the owner's capacity for attracting mates [4].

Due to increasing human populations, anthropogenic environments are continuously replacing native ecosystems [5]. This loss of natural environments has caused various biotic and abiotic effects on native ecosystems. Human behaviors frequently impact both the natural areas adjacent to human settlements and the organisms residing in these areas. Numerous bird species incorporate anthropogenic material into their nests due to growing availability of pollutants globally [6]. The prevalence and type of anthropogenic nest materials (ANMs) used vary depending on availability; however, they can also depend on the preference of species or other variables [7].

Plenty of research has been done on the use of ANMs by seabirds [8,9,10,11,12,13]. However, terrestrial birds may have a higher amount of ANMs incorporated in their nests [6]. Numerous terrestrial birds, particularly passerine birds, have been found to use ANMs [14,15,16,17,18,19,20,21,22,23,24,25,26,27]. These behaviors occur in a variety of families within the order Passeriformes; nevertheless, the inclusion of ANMs in wrens of the family Troglodytidae has seldom been reported [28,29]. Likewise, in Latin America, these types of ecological records are rarely published. Despite its high biodiversity, the field of ecology of this region amounts to merely 9% of worldwide publications [30].

Troglodytes aedon (Vieillot, 1809) is a passerine bird belonging to the family Troglodytidae. Widely distributed, this species inhabits a vast range throughout the Americas, from southern Canada to the southernmost point of Argentina [31,32]. It exhibits a preference for habitats such as inter-Andean valleys and often coexists with human populations in various ecosystems [33,34,35,36]. In these areas, it is uncertain how urban anthropogenic disturbance affects the House Wren's ecological behaviors, like singing, diet, predation, or nesting [37,38,39,40]. In this paper, we document the use of ANMs by a House Wren (*Troglodytes aedon*).

On November 26, 2023, at 11:11 am, we observed for ~20 min and photographed one individual House Wren at the lookout located at the entrance of Parque Los Algarrobos in Cumbayá, Pichincha Province, Ecuador (-0.206636, -78.420660, WGS84). This individual was observed carrying a piece of transparent plastic in its beak (see Fig 1). The plastic material appeared to be from an aged clear wrapper or plastic bag with an elongated shape. The House Wren was identified following the Fieldbook of the Birds of Ecuador [41], based on its striped, brown coloration and pale-brown venter as diagnostic features.

The House Wren was initially spotted on the branches of a castor bean plant (*Ricinus communis*), approximately 7 m from the outlook towards the metropolitan park (Fig. 1A). From there, it traversed from branch to branch into a chilca plant (*Baccharis latifolia*) (Fig. 1B) and subsequently flew towards a streetlamp on the deck structure of the viewpoint. Entering the lamp (Fig. 1C), it reemerged about 1 min later without the piece of plastic. The wren then vocalized for about 2 min (Fig. 1D), positioned itself on top of the lamp post, and continued vocalizing (see Fig. 1E); this behavior persisted for approximately 10 min.

 DOI: https://doi.org/10.18272/aci.v16i1.3169

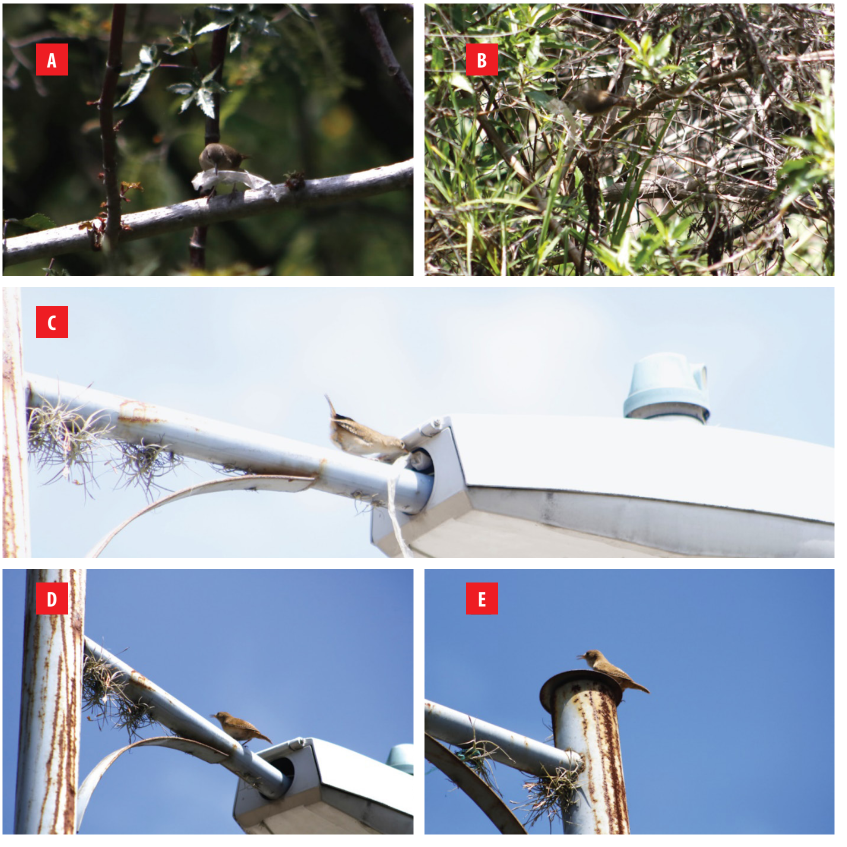

Figure 1. A: House Wren holding a piece of plastic on a Castor Bean plant. **B:** House Wren holding the piece of plastic on a chilca plant. **C:** House Wren entering streetlamp-nest with the piece of plastic. **D:** House Wren emerging from the streetlamp without the piece of plastic and vocalizing. **E:** House Wren on top of the streetlamp post vocalizing.

The observation of a House Wren individual incorporating ANMs into its nest raises intriguing questions about the factors influencing the use of these nest materials by urban land birds. In temperate areas, House Wren nesting is well documented. These reports include the use of artificial structures in disturbed areas and the occasional use of ANMs. Reported elements used to build nests include hanging sacks, oil cans, animal skulls, wooden beams, etc. [36,41,42,43]. This variety of materials demonstrates the species' adaptability to withstand human changes and environments but does not imply clear preferences for any element.

Five hypotheses have been proposed to explain the use of ANMs for birds in urban areas. (1) The *Availability Hypothesis* argues that the most common materials in the environment are going to be incorporated into nests, and thus the reduction of native plants in nesting areas can lead to the increase of ANMs due to their functional resemblance to natural nesting material [27,44,45]. (2) The *Age Hypothesis* states that

 DOI: https://doi.org/10.18272/aci.v16i1.3169

in urban areas, where birds tend to reach older ages, experienced (older) birds may use more ANMs due to their known resemblance to native materials [44,45,46,47]. (3) The *New Location Hypothesis* posits that novel nesting sites, such as buildings or nest boxes, challenge birds to acquire new nesting materials such as ANMs [45,48,49,50]. (4) The *Adaptive Hypothesis* posits that alterations in nest building materials and behavior stem from their adaptive value, with novel materials chosen for intrinsic benefits like antimicrobial activity or versatility [51,52,53,54]. Additionally, within this hypothesis, sexual selection may contribute, as suggested by the (5) *Signaling Hypothesis,* which proposes that as an extended phenotype, birds utilize ANMs to indicate reproductive quality through nest building [55,56,57].

The observed behavior seems to align with various of these hypotheses. However, we lean toward the *Availability Hypothesis*, which suggests that the scarcity of native plants may drive House Wrens to incorporate ANMs. The transparent plastic used by the House Wren, resembling natural materials with its elongated shape, might serve as an alternative amidst diminishing native resources. Additionally, the use of a streetlamp as a nesting structure could support the *New Location Hypothesis*, indicating the House Wrens' adaptation to unconventional nesting sites. Another intriguing possibility is that the observed behavior aligns with the *Signaling Hypothesis*. The vocalization of the male House Wren during nest building suggests a potential attraction mechanism, intertwining nest construction and mate attraction. The interplay of various factors from these hypotheses adds complexity to our understanding of the observed behavior.

In conclusion, this observation provides insights into the complex interplay of factors influencing avian nest-building behaviors in urban environments. Further studies are warranted to explore the prevalence of ANMs in wren nests and to unravel the underlying mechanisms and adaptive significance of such behaviors. Understanding these dynamics is crucial for the effective conservation and management of urban bird populations in the face of ongoing environmental changes and human population growth.

ACKNOWLEDGEMENTS

We express our gratitude to everyone who participated in the "Gran Bioblitz del Sur" for their valuable assistance and participation in the event. Special thanks to the Laboratorio de Zoología Terrestre and the Museo de Zoología ZSFQ, within the Instituto de Biodiversidad Tropical IBIOTROP, at Universidad San Francisco de Quito USFQ, for their support in organizing such events and fostering our curiosity, enabling us to share this valuable information. Additionally, we extend our appreciation to Elisa Bonaccorso and the anonymous reviewers for their valuable suggestions on this manuscript.

AUTHOR CONTRIBUTIONS

Mateo Dávila-Játiva, Roberto J. León-E., and Ariel Guerrero-Campoverde spotted the nest building event together and contributed to the writing of the manuscript. Mateo Dávila-Játiva took the pictures and prepared the figure.

DOI: https://doi.org/10.18272/aci.v16i1.3169

aci avances en ciencias e ingenierías

REFERENCES

[1] Hansell, M. H. (2005). *Animal Architecture*. OUP Oxford.

[2] Mainwaring, M. C., Reynolds, S. J. & Weidinger, K. (2015). The influence of predation on the location and design of nests. In D. C. Deeming & S. J. Reynolds (Eds.), *Nests, Eggs, and Incubation: New ideas about avian reproduction* (p.0). Oxford University Press. doi: https://doi.org/10.1093/acprof:oso/9780198718666.003.0005

[3] Medina, I., M. Perez, D., Silva, A. C. A., Cally, J., León, C., Maliet, O. & Quintero, I. (2022). Nest architecture is linked with ecological success in songbirds. *Ecology Letters*, *25*(6), 1365–1375. doi: https://doi.org/10.1111/ele.13998

[4] Madden, J. (2001). Sex, bowers and brains. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *268*(1469), 833–838. doi: https://doi.org/10.1098/rspb.2000.1425

[5] Western, D. (2001). Human-modified ecosystems and future evolution. *Proceedings of the National Academy of Sciences*, *98*(10), 5458–5465. doi: https://doi.org/10.1073/pnas.101093598

[6] Jagiello, Z., Dylewski, Ł., Tobolka, M. & Aguirre, J. I. (2019). Life in a polluted world: A global review of anthropogenic materials in bird nests. *Environmental Pollution*, *251*, 717–722. doi: https://doi.org/10.1016/j.envpol.2019.05.028

[7] Batisteli, A. F., Guilhermo-Ferreira, R. & Sarmento, H. (2019). Abundance and prevalence of plastic twine in nests of Neotropical farmland birds. *The Wilson Journal of Ornithology*, *131*(1), 201. doi: https://doi.org/10.1676/18-24

[8] Grant, M. L., Lavers, J. L., Hutton, I. & Bond, A. L. (2021). Seabird breeding islands as sinks for marine plastic debris. *Environmental Pollution*, *276*, 116734. doi: https://doi.org/10.1016/j.envpol.2021.116734

[9] O'Hanlon, N. J., James, N. A., Masden, E. A. & Bond, A. L. (2017). Seabirds and marine plastic debris in the northeastern Atlantic: A synthesis and recommendations for monitoring and research. *Environmental Pollution*, *231*, 1291–1301. doi: https://doi.org/10.1016/j.envpol.2017.08.101

[10] O'Hanlon, N. J., Bond, A. L., Masden, E. A., Lavers, J. L. & James, N. A. (2021). Measuring nest incorporation of anthropogenic debris by seabirds: An opportunistic approach increases geographic scope and reduces costs. *Marine Pollution Bulletin*, *171*, 112706. doi: https://doi.org/10.1016/j.marpolbul.2021.112706

[11] Ryan, P. G. (2020). Using photographs to record plastic in seabird nests. *Marine Pollution Bulletin*, *156*, 111262. doi: https://doi.org/10.1016/j.marpolbul.2020.111262

[12] Tavares, D. C., Moura, J. F., Acevedo-Trejos, E., Crawford, R. J. M., Makhado, A., Lavers, J. L., Witteveen, M., Ryan, P. G. & Merico, A. (2020). Confidence intervals and sample size for estimating the prevalence of plastic debris in seabird nests. *Environmental Pollution*, *263*, 114394. doi: https://doi.org/10.1016/j.envpol.2020.114394

[13] Yorio, P., Suárez, N., Ibarra, C., Gonzalez, P., Canti, S., Kasinsky, T. & Marinao, C. (2022). Anthropogenic debris in Kelp Gull and other seabird nests in northern Patagonia, Argentina. *Marine Pollution Bulletin*, *175*, 113404. doi: https://doi.org/10.1016/j.marpolbul.2022.113404

[14] Antczak, M., Hromada, M., Czechowski, P., Tabor, J., Zabłocki, P., Grzybek, J. & Tryjanowski, P. (2010). A new material for old solutions—The case of plastic string used in Great Grey Shrike nests. *Acta Ethologica*, *13*(2), 87–91. doi: https://doi.org/10.1007/s10211-010-0077-2

[15] Azevedo-Santos, V. M., Giarrizzo, T. & Arcifa, M. S. (2022). Plastic use by a Brazilian freshwater bird species in its nesting activities. *Water Biology and Security*, *1*(4), 100065. doi: https://doi.org/10.1016/j.watbs.2022.100065

[16] Blettler, M. C. M., Gauna, L., Andréault, A., Abrial, E., Lorenzón, R. E., Espinola, L. A. & Wantzen, K. M. (2020). The use of anthropogenic debris as nesting material by the greater thornbird, an inland–wetland-associated bird of South America. *Environmental Science and Pollution Research*, *27*(33), 41647–41655. doi: https://doi.org/10.1007/s11356-020-10124-4

[17] Borgia, G. (1985). Bower quality, number of decorations and mating success of male satin bowerbirds (Ptilonorhynchus violaceus): An experimental analysis. *Animal Behaviour*, *33*(1), 266–271. doi: https://doi.org/10.1016/S0003-3472(85)80140-8

[18] Briggs, K. B., Deeming, D. C. & Mainwaring, M. C. (2023). Plastic is a widely used and selectively chosen nesting material for pied flycatchers (Ficedula hypoleuca) in rural woodland habitats. *Science of The Total Environment*, *854*, 158660. doi: https://doi.org/10.1016/j.scitotenv.2022.158660

[19] Broughton, R. K. & Parry, W. (2019). A Long-tailed Tit *Aegithalos caudatus* nest constructed from plastic fibres supports the theory of concealment by light reflectance. *Ringing & Migration*, *34*(2), 120–123. doi: https://doi.org/10.1080/03078698.2019.1830518

[20] Carbó-Ramírez, P., González-Arrieta, R. A. & Zuria, I. (2015). Breeding Biology of the Rufous-backed Robin (*Turdus rufopalliatus*) in an Urban Area Outside its Original Distribution Range. *The Wilson Journal of Ornithology*, *127*(3), 515–521. doi: https://doi.org/10.1676/14-056.1

[21] Gosler, A. G. (1987). Pattern and process in the bill morphology of the Great Tit Parus major. *Ibis*, *129*(s2), 451–476. doi: https://doi.org/10.1111/j.1474-919X.1987.tb08234.x

[22] Harvey, J. A., Chernicky, K., Simons, S. R., Verrett, T. B., Chaves, J. A. & Knutie, S. A. (2021). Urban living influences the nesting success of Darwin's finches in the Galápagos Islands. *Ecology and Evolution*, *11*(10), 5038–5048. doi: https://doi.org/10.1002/ece3.7360

[23] Igic, B., Cassey, P., Samaš, P., Grim, T. & Hauber, M. (2009). Cigarette butts form a perceptually cryptic component of Song Thrush (Turdus philomelos) nests. *Notornis*, *56*, 134–138.

[24] Järvinen, P. & Brommer, J. E. (2020). Lining the nest with more feathers increases offspring recruitment probability: Selection on an extended phenotype in the blue tit. *Ecology and Evolution*, *10*(23), 13327–13333. doi: https://doi.org/10.1002/ece3.6931

[25] Kucherenko, V. M. & Ivanovskaya, A. V. (2020). Variation in common blackbird (Turdus merula) nest characteristics in urban and suburban localities in Crimea. *Zoodiversity*, *54*(2), 157–162. doi: https://doi.org/10.15407/zoo2020.02.157

[26] Townsend, A. K. & Barker, C. M. (2014). Plastic and the Nest Entanglement of Urban and Agricultural Crows. *PLoS ONE*, *9*(1), e88006. doi: https://doi.org/10.1371/journal.pone.0088006

[27] Wang, Y., Chen, S., Blair, R. B., Jiang, P. & Ding, P. (2009). Nest composition adjustments by Chinese Bulbuls <I>Pycnonotus sinensis</I> in an urbanized landscape of Hangzhou (E China). *Acta Ornithologica*, *44*(2), 185–192. doi: https://doi.org/10.3161/000164509X482768

[28] Cristofoli, S. I. & Sander, M. (2007). Composição do ninho de corruíra: Troglodytes musculus Naumann, 1823 (Passeriformes: Troglodytidae). *Biodiversidade Pampeana*, *5*(2). https://revistaseletronicas.pucrs.br/ojs/index.php/biodiversidadepampeana/article/view/2628

[29] Rusnak, C. M. & Labisky, R. F. (2003). *Carolina Wren (Thryothorus ludovicianus)*.

[30] Wojciechowski, J., Ceschin, F., Pereto, S. C. a. S., Ribas, L. G. S., Bezerra, L. a. V., Dittrich, J., Siqueira, T., & Padial, A. A. (2017). Latin American scientific contribution to ecology. *Anais Da Academia Brasileira de Ciências*, *89*, 2663–2674. doi: https://doi.org/10.1590/0001-3765201720160535

[31] Levin, R. N., Correa, S. M., Freund, K. A. & Fuxjager, M. J. (2023). Latitudinal and elevational variation in the reproductive biology of house wrens, Troglodytes aedon. *Ecology and Evolution*, *13*(9), e10476. doi: https://doi.org/10.1002/ece3.10476

[32] Tubaro, P. L. (1990). Song description of the House Wren (Troglodytes aedon) in two populations of eastern Argentina, and some indirect evidences of imitative vocal learning. *El Hornero*, *013*(02). https://bibliotecadigital.exactas.uba.ar/collection/hornero/document/hornero_v013_n02_p111

[33] Hilty, S. L. & Brown, W. L. (1986). *A Guide to the Birds of Colombia*. Princeton University Press.

[34] Ridgely, R. S. & Greenfield, P. J. (2001). *The birds of Ecuador: Vol. Volume 1: Status, distribution and taxonomy.* New York: Comstock/Cornell Paperbacks, Cornell University Press

[35] Freile, J. & Restall, R. (2018). Birds of Ecuador. London: Bloomsbury Publishing.

[36] Rocha (2021). Guía completa para conocer Aves del Uruguay 2da ed. Edición de la banda Banda Oriental.

[37] Muller, K. L., Stamps, J. A., Krishnan, V. V. & Willits, N. H. (1997). The effects of conspecific attraction and habitat quality on habitat selection in territorial birds (Troglodytes aedon). *The American Naturalist*, *150*(5), 650-661. doi: https://doi.org/10.1086/286087

[38] Heppner, J. J. & Ouyang, J. Q. (2021). Incubation behavior differences in urban and rural house wrens, Troglodytes aedon. *Frontiers in Ecology and Evolution*, *9*, 590069. doi: https://doi.org/10.3389/fevo.2021.590069

[39] Sementili-Cardoso, G. & Donatelli, R. J. (2021). Anthropogenic noise and atmospheric absorption of sound induce amplitude shifts in the songs of Southern House Wren (Troglodytes aedon musculus). *Urban Ecosystems*, *24*(5), 1001-1009. doi: https://doi.org/10.1007/s11252-021-01092-9

[40] vonHoldt, B. M., Kartzinel, R. Y., van Oers, K., Verhoeven, K. J. & Ouyang, J. (2021). Reorganization of molecular networks associated with DNA methylation and changes in the rearing environments of the house wren (Troglodytes aedon). *bioRxiv*, 2021-05. doi: https://doi.org/10.1101/2021.05.04.442647

[41] McMullan, M. & Navarrete, L. (2017). *Fieldbook of the birds of Ecuador, including the Galapagos islands and common mammals.* Second edition. Quito: Ratty Ediciones.

[42] Atienzar, F., Belda, E. & Greño, J. (2010). Comparación de materiales utilizados en la construcción del nido y de los parámetros reproductores en el chochín *Troglodytes troglodytes* en la Font Roja y en la Sierra de Mariola. *Iberis* 8: 17-22.

[43] Honorato, M. T., Altamirano, T. A., Ibarra, J. T., De la Maza, M., Bonacic, C. & Martin, K. (2016). Composición y preferencia de materiales en nidos de vertebrados nidificadores de cavidades en el bosque templado andino de Chile. *Bosque (Valdivia)*, *37*(3), 485-492.

[44] Jagiello, Z. A., Dylewski, Ł., Winiarska, D., Zolnierowicz, K. M. & Tobolka, M. (2018). Factors determining the occurrence of anthropogenic materials in nests of the white stork Ciconia ciconia. *Environmental Science and Pollution Research*, *25*(15), 14726–14733. doi: https://doi.org/10.1007/s11356-018-1626-x

[45] Reynolds, S. J., Ibáñez-Álamo, J. D., Sumasgutner, P. & Mainwaring, M. C. (2019). Urbanisation and nest building in birds: A review of threats and opportunities. *Journal of Ornithology*, *160*(3), 841–860. doi: https://doi.org/10.1007/s10336-019-01657-8

[46] Evans, K. L., Newson, S. E. & Gaston, K. J. (2009). Habitat influences on urban avian assemblages. *Ibis*, *151*(1), 19–39. doi: https://doi.org/10.1111/j.1474-919X.2008.00898.x

[47] Ibáñez-Álamo, J. D., Pineda-Pampliega, J., Thomson, R. L., Aguirre, J. I., Díez-Fernández, A., Faivre, B., Figuerola, J. & Verhulst, S. (2018). Urban blackbirds have shorter telomeres. *Biology Letters*, *14*(3), 20180083. doi: https://doi.org/10.1098/rsbl.2018.0083

[48] Reynolds, S. J., Davies, C. S., Elwell, E., Tasker, P. J., Williams, A., Sadler, J. P. & Hunt, D. (2016). Does the Urban Gradient Influence the Composition and Ectoparasite Load of Nests of an Urban Bird Species? *Avian Biology Research*, *9*(4), 224–234. doi: https://doi.org/10.3184/175815516X14725499175665

[49] Wang, Y., Chen, S., Jiang, P. & Ding, P. (2008). Black-billed Magpies (Pica pica) adjust nest characteristics to adapt to urbanization in Hangzhou, China. *Canadian Journal of Zoology*, *86*(7), 676–684. doi: https://doi.org/10.1139/Z08-045

[50] Wang, Y., Huang, Q., Lan, S., Zhang, Q. & Chen, S. (2015). Common blackbirds Turdus merula use anthropogenic structures as nesting sites in an urbanized landscape. *Current Zoology*, *61*(3), 435–443. doi: https://doi.org/10.1093/czoolo/61.3.435

[51] Clayton, D. H. & Wolfe, N. D. (1993). The adaptive significance of self-medication. *Trends in Ecology & Evolution*, *8*(2), 60–63. doi: https://doi.org/10.1016/0169-5347(93)90160-Q

[52] Suárez-Rodríguez, M., López-Rull, I. & Macías Garcia, C. (2013). Incorporation of cigarette butts into nests reduces nest ectoparasite load in urban birds: New ingredients for an old recipe? *Biology Letters*, *9*(1), 20120931. doi: https://doi.org/10.1098/rsbl.2012.0931

[53] Suárez-Rodríguez, M. & Macías Garcia, C. (2014). There is no such a thing as a free cigarette; lining nests with discarded butts brings short-term benefits, but causes toxic damage. *Journal of Evolutionary Biology*, *27*(12), 2719–2726. doi: https://doi.org/10.1111/jeb.12531

[54] Suárez-Rodríguez, M. & Garcia, C. M. (2017). An experimental demonstration that house finches add cigarette butts in response to ectoparasites. *Journal of Avian Biology*, *48*(10), 1316–1321. doi: https://doi.org/10.1111/jav.01324

[55] Jagiello, Z., Corsini, M., Dylewski, Ł., Ibáñez-Álamo, J. D. & Szulkin, M. (2022). The extended avian urban phenotype: Anthropogenic solid waste pollution, nest design, and fitness. *Science of The Total Environment*, *838*, 156034. doi: https://doi.org/10.1016/j.scitotenv.2022.156034

[56] Jagiello, Z., Reynolds, S. J., Nagy, J., Mainwaring, M. C. & Ibáñez-Álamo, J. D. (2023). Why do some bird species incorporate more anthropogenic materials into their nests than others? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *378*(1884), 20220156. doi: https://doi.org/10.1098/rstb.2022.0156

[57] Schaedelin, F. C. & Taborsky, M. (2009). Extended phenotypes as signals. *Biological Reviews*, *84*(2), 293–313. doi: https://doi.org/10.1111/j.1469-185X.2008.00075.x