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Research paper

From *pardal* to *etxe-txolarrea*: An integrative review of the house sparrow *Passer domesticus* knowledge in the Iberian Peninsula

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Abstract

From pardal to etxe-txolarrea: An integrative review of the house sparrow Passer domesticus *knowledge in the Iberian Peninsula*. House sparrows, native to the Middle and Near East, have expanded –naturally or with human assistance– to nearly every continent except Antarctica. As a highly anthropodependent species, they have been extensively studied, with over 7,000 research articles published worldwide. In the Iberian Peninsula, house sparrows have long been a familiar presence in cities and farmlands. However, there is a lack of integrative research that synthesizes the existing scientific knowledge on this species. Our review focuses on existing literature to identify spatio-temporal patterns, highlight knowledge gaps, and guide future directions on the research focused on the species. By the use of bibliometric and systematic search approaches, we analyzed 114 peer-reviewed articles conducted in the Iberian Peninsula and focused on house sparrows. Research in this region on this species began in the mid 1980s. Studies have focused mostly on its health (e.g., parasitism, infection rates, physiology), biology (e.g., reproduction, morphology, hybridization, adaptability), behavior (e.g., boldness, social signaling, dominance, infanticide, intraspecific brood parasitism, egg rejection), and ecology (e.g., population trends, habitat selection, abundance, density). Most studies, led by long-standing research groups, have been concentrated in Spain: Madrid, Barcelona, Seville, Huelva, and Badajoz, dominating the research of these topics, while only 5 studies were indentified for Portugal. Besides the geographic bias, we identified critical knowledge gaps, particularly regarding the species' conservation. Future research may benefit from prioritizing large-scale population studies, distinguish urban and non-urban trends, enhance knowledge of other native sparrows for comparative analyses, and foster collaboration to develop standardized census methods to gain a comprehensive picture of the species' status.

Key words: Ornithology, Urban ecology, Behavior, Conservation, Birds, Health

Resumen

De pardal a etxe-txolarrea: Una revisión integrativa del conocimiento del gorrión común Passer domesticus *en la Península Ibérica*. El gorrión común, originario de Oriente Próximo y Oriente Medio, se ha extendido –de forma natural o con asistencia humana indirecta– a casi todos los continentes excepto la Antártida. Como especie altamente antropodependiente, ha sido objeto de numerosos estudios, con más de 7.000 artículos de investigación publicados en todo el mundo. En la Península Ibérica, los gorriones comunes son desde hace mucho tiempo una presencia familiar en ciudades y campos de cultivo. Sin embargo, faltan investigaciones integrativas que sinteticen el conocimiento científico existente sobre esta especie. Nuestra revisión se centra en la literatura existente para identificar patrones espacio-temporales, resaltar lagunas de conocimiento y orientar futuras direcciones en la investigación centrada en la especie. Mediante el uso de enfoques bibliométricos y de búsqueda sistemática, analizamos 114 artículos revisados por pares realizados en la Península Ibérica y centrados en el gorrión común. La investigación en esta región sobre esta especie comenzó a mediados de la década de 1980. Los estudios se han centrado principalmente en su salud (p. ej., parasitismo, tasas de infección, fisiología), biología (p. ej., reproducción, morfología, hibridación, adaptabilidad), comportamiento (p. ej., audacia, señalización social, dominancia, infanticidio, parasitismo de cría intraespecífico, rechazo de huevos) y ecología (p. ej., tendencias poblacionales, selección de hábitat, abundancia, densidad). La mayoría de los estudios, liderados por grupos de investigación de larga trayectoria, se han concentrado en España: Madrid, Barcelona, Sevilla, Huelva y Badajoz, dominando la investigación de estos temas, mientras que solo se identificaron 5 estudios para Portugal. Además del sesgo geográfico, identificamos lagunas críticas de conocimiento, particularmente en lo que respecta a la conservación de la especie. La investigación futura debería priorizar los estudios poblacionales a gran escala, distinguir las tendencias urbanas de las no-urbanas, mejorar el conocimiento de otros gorriones nativos para realizar análisis comparativos, y fomentar la colaboración para desarrollar métodos de censo estandarizados que permitan comprender plenamente el estado de la especie.

Palabras clave: Ornitología, Ecología urbana, Comportamiento, Conservación, Aves, Salud

Introduction

The house sparrow *Passer domesticus* Linnaeus, 1758 is a small, sexually dimorphic bird in the family Passeridae and one of the most emblematic examples of a wild bird species that commensally associates with humans (Summers-Smith 1988, Anderson 2006, Lowther and Cink 2020). They are so closely associated with human presence that they are considered anthropodependent (Hulme-Beaman et al 2016, Hanson et al 2020), relying on human-modified environments and their associated resources, not only in agricultural landscapes –where this association likely first evolved– but also in urban areas, where they often face local extinction if these areas are abandoned by humans (Summers-Smith 1963, Anderson 2006, Sætre et al 2012). This close relationship led Carl Linnaeus, in 1758, to name the species '*domesticus*', derived from the Latin *domus* "house" (Anderson 2006, Jobling 2009, Hanson et al 2020). As a result of this association, house sparrows have successfully adapted to urban life, demonstrating remarkable resilience in human-altered environments. Their ubiquity makes them a key species for studying urban wildlife and broader ecological and evolutionary topics, including life history evolution, body size variation, sexual selection, and genetic, genomic, and epigenetic changes during range expansion. Notably, over 7,000 research articles have been published on this species worldwide (Anderson 2006, Summers-Smith 2009, Hanson et al 2020).

House sparrows are native to the Middle and Near East (Anderson 2006, Sætre et al 2012, Lowther and Cink 2020). Their close association with humans likely began during the Neolithic Revolution, around 6,000 years ago, with the spread of agriculture (Sætre et al 2012, Ravinet et al 2018). Recent molecular analyses indicate that house sparrows diverged from a *Bactrianus* population, a non-commensal group from the Near East, which split from more modern populations approximately 11,000 years ago (Ravinet et al 2018). The species most likely expanded its range into Northern and Eastern Europe and Central Asia in the early 1800s, coinciding with the rise of modern agriculture and urbanization (Summers-Smith 1963, 1988). In addition to their strong affinity for human settlements, they can thrive in a wide range of habitats, from sea level to elevations of 4,500 meters, wherever food is available (Clement et al 1993).

Several well-documented exotic and invasive house sparrow populations have successfully established and expanded worldwide. In North America, the first introduction occurred in 1851 in Brooklyn, USA (Brown and Wilson 1975), followed by a successful establishment one year later (Summers-Smith 1988). By the end of the century, the species was present in all USA states and had reached the northern agricultural limits in Canada (Summers-Smith 1988). It rapidly expanded most of North America except for the Florida Peninsula, that took longer to colonize, and for the Yucatán Peninsula, where sparrows have not currently yet invaded (Peña-Peniche et al 2021). In South America, they were introduced to Buenos Aires (Argentina) in 1872-1873, Santiago (Chile) in 1904, and Rio de Janeiro (Brazil) in 1905 (Long 1981, Lever 1987, Summers-Smith 1988), and subsequently expanded in the continent, even crossing the Equator. Notably, the invasions of North and South America are independent, as the species is unable to cross the Darién Gap. In South Africa, the nominal group was introduced from Great Britain between 1907 and 1930 in East London (Summers-Smith 1988, Anderson 2006), and in Australia, house sparrows were first introduced in 1863 (Sage 1957, Long 1981, Lever 1987). Through numerous accidental and intentional introductions over the past 170 years, house sparrows have successfully colonized nearly every continent except Antarctica (Summers-Smith 1988, BirdLife International 2016).

House sparrows were considered pests in the 17th and 19th centuries due to their abundance in agricultural and urban areas (Robinson et al 2005, Torres-Vila et al 2015). This perception persists in some of the regions they have invaded or range-expanded at, while in others, it has faded. Despite being widespread, house sparrow populations have declined significantly across their native Eurasian range since the 1970s (Summers-Smith 1988, Mohring et al 2021, Ramos-Elvira et al 2023) or in India since 2005 (Sharma and Binner 2020) and more recently in their invasive range such as in North America (Berigan et al 2020). The IUCN (2021) has classified the house sparrow as a species of "Least Concern" in Europe, but it recognizes a declining population trend. The species was added to the Red List of birds of high conservation concern in the UK in 2002 following a >50% decline in breeding populations over 25 years (Galbraith 2002, Robinson et al 2005) and as near-threatened species in the Netherlands in 2004 (van Kleunen et al 2017) and in Germany in 2002 (Engler and Bauer 2002). While some recovery has been observed in Scotland and Wales, house sparrows remain on the list (Stanbury et al 2021).

The causes of these declines remain debated, with factors including disease, predation increase, pollution, pesticide use, modern building practices, and agricultural intensification (Shaw et al 2008, Peach et al 2018, Dadam et al 2019). Urban declines are particularly puzzling, as artificial feeding is common (Robinson et al 2005, Reynolds et al 2017). A historical parallel exists with Britain's decline in the 1920s, when the replacement of horses with automobiles reduced food sources (Summers-Smith 1963). Today, improved waste management may be having a similar effect (Bernat-Ponce et al 2022). Similarly, a simulation study on the recolonization of Britain by the Eurasian sparrowhawk *Accipiter nisus* from the 1970s, coupled with the concurrent decline of the house sparrow population, suggests that predation may have played a key role (Bell et al 2010). The most accepted hypothesis suggests that multiple interacting stressors are driving house sparrow declines (Anderson 2006, De Coster et al 2015).

The house sparrow presents intricate patterns of hybridization and taxonomic complexity that have significant evolutionary and conservation implications (Anderson 2006). Hybridization with closely related species such as *Passer hispaniolensis*, the Spanish sparrow, has produced stabilized hybrid forms, including *Passer italiae*, the Italian sparrow, and extensive introgression zones across southern Europe and North Africa (Anderson 2006, Ait Belkacem et al 2016). These processes blur taxonomic boundaries and underscore the need for integrated morphological, genetic, and ecological approaches to accurately delineate populations. Moreover, populations such as the Balearoibericus group (historically proposed as a subspecies of the house sparrow, and once thought to be native to the Iberian Peninsula and the Balearic Islands; Murgui 2016) illustrate geographic and genetic structuring within the species, reinforcing the importance of understanding hybridization dynamics for conservation management and the interpretation of morphological variation. Overall, compiling current knowledge on the species in the Iberian Peninsula is therefore both relevant and timely.

In the Iberian Peninsula, the house sparrow has been a familiar sight in cities and farmlands for thousands of years, making it one of the most recognizable and culturally significant birds of this biogeographical region, as it appears in literature, songs, and folklore as a symbol of everyday life and resilience (Mejía et al 1983, Murgui 2022a). The house sparrow is not red-listed in Spain, nor in Portugal or the IUCN and is still classified as a "Least Concern" species despite its overall declining population (Murgui and Macias 2010, IUCN 2021, SEO/BirdLife 2021, Almeida et al 2022, Ramos-Elvira et al 2023). However, in specific regions of the Iberian Peninsula, such as Catalonia (northeastern Spain), it was classified as "Near Threatened" in 2012 (Anton et al 2013). Despite this long-standing coexistence, scientific research on the species only began in the mid-1980s and has expanded importantly over the past four decades. Thus, here we dive into the existing knowledge of the species across the Iberian Peninsula to identify spatio-temporal patterns, highlight knowledge gaps, and guide future research directions.

Material and methods

Literature review

We conducted a systematic literature search on 13/06/2024, using Web of Science (WoS; All Databases; www.webofscience.com), focusing exclusively on peer-reviewed publications while excluding technical reports, conference proceedings, and similar sources. While we acknowledge the value of knowledge contained in non-peer-reviewed sources, their variable quality, limited accessibility, and lack of standardized reporting can hinder reproducibility and critical appraisal. Therefore, their exclusion was considered necessary to maintain the rigor and transparency of the review, in line with established methodological standards for systematic reviews. To conduct this systematic review, we primarily followed the methods outlined by Lozano et al (2019) and Marín-Gómez and MacGregor-Fors (2021), with slight variations in our approach. Our search covered all available years and was performed using the 'Topic' field (title, abstract, keyword plus, and author keywords). To ensure comprehensive coverage, we did not restrict our search to publications in English, Portuguese or Spanish. Given the linguistic diversity of the Iberian Peninsula, we included the common names for the house sparrow across the region's languages: *Gorrión común* (Castillian; Spanish), *Pardal comú/Pardal* (Galician, Catalan, Majorcan, and Portuguese), *Teuladí* (Valencian), and *Etxe-txolarrea* (Basque).

We formulated the search string using the following Boolean operator query: TS = (("Passer domesticus" OR "P. domesticus" OR "House Sparrow*" OR "English Sparrow*" OR "Common Sparrow*" OR "gorrion* comun*" OR "pardal* comu*" OR "teuladi*" OR "etxe-txolarre*" OR "pardal*") AND ("Spain" OR "Portugal" OR "Iberian Peninsula" OR "Mediterranean region" OR "South* Europe" OR "España")). This search yielded 356 results, which we then screened for relevance. We retained the 98 articles that met the criteria for this review, namely: studies conducted in the Iberian Peninsula, in which the house sparrow was the primary focus, either as a main research objective or a central species in the results. We excluded papers that analyzed broader ecological patterns without a specific focus on the house sparrow or those where the species was merely one of many in a dataset (e.g., studies on avian diversity or parasite communities).

To broaden and complement our search, we conducted an additional non-systematic search in Google Scholar (GS; https://scholar.google.com), which covers a diverse range of sources, including peer-reviewed journal articles, theses, dissertations, monographs, book chapters, and conference proceedings (Marín-Gómez and MacGregor-Fors 2021, Luna and Rausell-Moreno 2024); however, our focus remained on peer-reviewed articles (Haddaway et al 2015). The search string used in Google Scholar was: "House Sparrow" OR "House Sparrows" OR "Passer domesticus" OR "P. domesticus" OR "gorrion comun" OR "pardal comu" OR "pardal" OR "teuladi" OR "etxe-txolarrea" AND "Spain" OR "España"

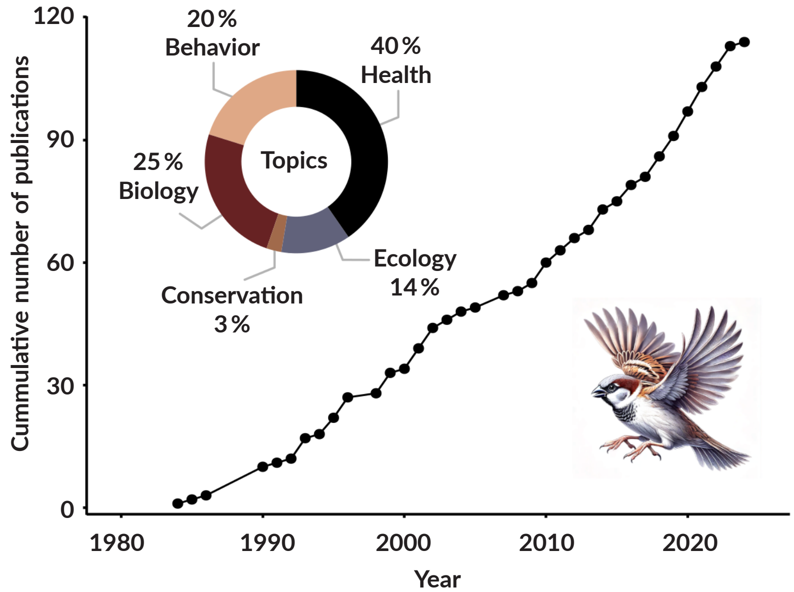

Fig. 1. Number of accumulated peer-reviewed articles focused on the house sparrow in the Iberian Peninsula. Pie-chart shows the proportion of studies by main topic. The illustration were generated using artificial intelligence tools and afterward modified by IM-F.

Fig. 1. *Número acumulado de artículos revisados por pares centrados en el gorrión común en la Península Ibérica. El gráfico circular muestra la proporción de estudios por tema principal. La ilustación fue generada con el uso de herramientas de inteligencia artificial, posteriormente modificadas por IM-F.*

OR "Portugal" OR "Iberian Peninsula", retrieving 21,400 documents. To refine the results, we screened the titles of the first 200 documents following Haddaway et al (2015), Marín-Gómez and MacGregor-Fors (2021) and Luna et al (2021), excluding those beyond the scope of this review. This process yielded 51 peer-reviewed journal articles, 37 of which were directly focused on the house sparrow in the Iberian Peninsula. To avoid duplication, we cross-checked all selected studies from WoS and GS, adding 16 new publications to those already identified in WoS. This brought the total number of articles on house sparrow research in the Iberian Peninsula to 114. The initial screening was conducted by EB-P to ensure consistency in selection criteria (the main steps of our literature selection process are summarized in the fig. S1).

Data extraction

From the 114 retained peer-reviewed articles, we extracted the following information: (i) year of publication, (ii) study location (Spanish provinces; Portuguese districts), (iii) title keywords (excluding connectors), (iv) main research topics, (v) study types, and (vi) study habitats. We categorized studies into five main research topics: behavior, biology, conservation, ecology, and health (see table S1 for details). Study types were classified into four categories: observational field/correlational field, experimental field, observational lab, and experimental captivity lab. Additionally, when available, we categorized studies based on house sparrow habitats. Given that the definition of "city" varies depending on geographical, political, and methodological factors (Bloom et al 2010, Qi and Deng 2024), we used a five-category classification for study sites: city, town, agricultural, natural environments, and captivity (see table S1 for details). A research paper can cover multiple provinces, study types, or habitats, meaning that category totals may exceed the number of papers. For analysis, each unique province, study type, or habitat was assigned one point. To systematically extract key findings, conclusions, and contributions from the 114 articles, we used SciSpace (https://typeset.io/; Jain et al 2024, Barrot 2025). All extracted information was manually reviewed for accuracy and enriched with additional relevant details from the original documents.

Results

Based on the material gathered for this review, the earliest studies on house sparrows in the Iberian Peninsula date to the mid-1980s, and a total of 114 peer-reviewed publications on the species were identified up to the search date (fig. 1; see table S2 for a summary of the 114 reviewed articles). However, we recognize that excluding non-peer-reviewed literature (often referred to as grey literature) omits early, valuable work on this species but ensures their scientific quality, accessibility, and reproducibility. Overall, most research has focused on the topics of behavior, biology, and health, while ecology –and particularly conservation– has been comparatively under-explored (fig. 1). The word cloud based on title keywords indicate that the most frequently studied topics in house sparrow research in the Iberian Peninsula are health-related, with terms such as infection, malaria, West Nile Virus, *Plasmodium*, immune response, and parasite being the most prominent (fig. 2). Most studies have been conducted in Spain (95.6 %), while only 4.4 % were carried out in Portugal. Geographically, the province of Madrid

Fig. 2. Word cloud synthesizing the most frequent keywords from peer-reviewed house sparrow articles, based on the titles of the reviewed publications.

Fig. 2. *Nube de palabras que sintetiza las palabras clave más frecuentes de los artículos revisados por pares sobre el gorrión común, basándose en los títulos de las publicaciones revisadas.*

(16.6 %), followed by Barcelona (10.2 %), Seville (9.6 %), and Badajoz (9.6 %), with Huelva (7.6 %) and Granada (6.4 %) also contributing notable research output. Studies in other Spanish provinces or Portuguese districts have been comparatively scarce, each accounting for less than 5 % of research efforts since 1984 (fig. 3).

Regarding study types, the most common in the reviewed literature were observational field studies, accounting for 41.2 % of the total. These were followed by observational lab studies (32.5 %) and experimental lab studies (26.3 %). Experimental field studies were the least frequent, comprising only 13.2 % of the research. When classifying studies by the origin of house sparrows, most research included birds from natural environments (34.2 %), cities (31.6 %), and agricultural areas and farmlands (29.8 %). In contrast, studies involving individuals from towns (19.3 %) and captive populations (14.9 %) were comparatively less common. Note that some classifications may not total 100 % due to papers covering multiple provinces/districts (14.9 %), study types (13.2 %), or habitats (25.4 %).

Main results by topic

Here, we summarize the main findings of the 114 reviewed articles on house sparrow research conducted in the Iberian Peninsula, categorized into the five key topics considered in this review from least to most represented: conservation (3), ecology (14), behavior (23), biology (28), and health (46).

Conservation

Only three of the 114 reviewed articles specifically addressed the conservation of the house sparrow, making it the least studied topic in the Iberian Peninsula, representing just 2.6 % of the documents in our review and all of them from Spain. Similar to trends observed in other European countries, current evidence shows that house sparrow populations are declining in some regions of the Iberian Peninsula, at least (Anton et al 2013; see section Ecology in Results), which may indicate broader changes in urban or agroecosystems that should be subject to ongoing vigilance and monitoring. In Valladolid, one study suggested that high electromagnetic pollution could be a contributing factor (Balmori and Hallberg 2007). However, this claim remains controversial, as other researchers in India found that electromagnetic radiation had no significant impact on the fine-scale habitat use of sparrows (Nath et al 2022). Other forms of pollution, such as noise pollution, have also been found to impact urban populations. For example, juvenile productivity declines in response to the loud recreational noise of traditional festivals in the Valencian Region (Bernat-Ponce et al 2021). Additionally, modern urban habitat management linked to urbanization poses a major threat to the species. House sparrow populations in eastern Spain declined after urban park renovations replaced semi-natural substrates with artificial materials, such as synthetic grass, to reduce water waste –likely reducing food availability (Bernat-Ponce et al 2020). Consequently, monitoring this common, yet ecologically interconnected species provides valuable insights as a bioindicator of overall ecosystem health and urban biodiversity trends.

Ecology

This topic covers 14 studies (12.3 %; all of them carried out in Spain) on house sparrow ecology, focusing on population trends, habitat selection, and factors influencing their abundance. Urban infrastructure and human activity often relate with sparrow numbers in the Iberian Peninsula and invaded areas, with various factors shaping

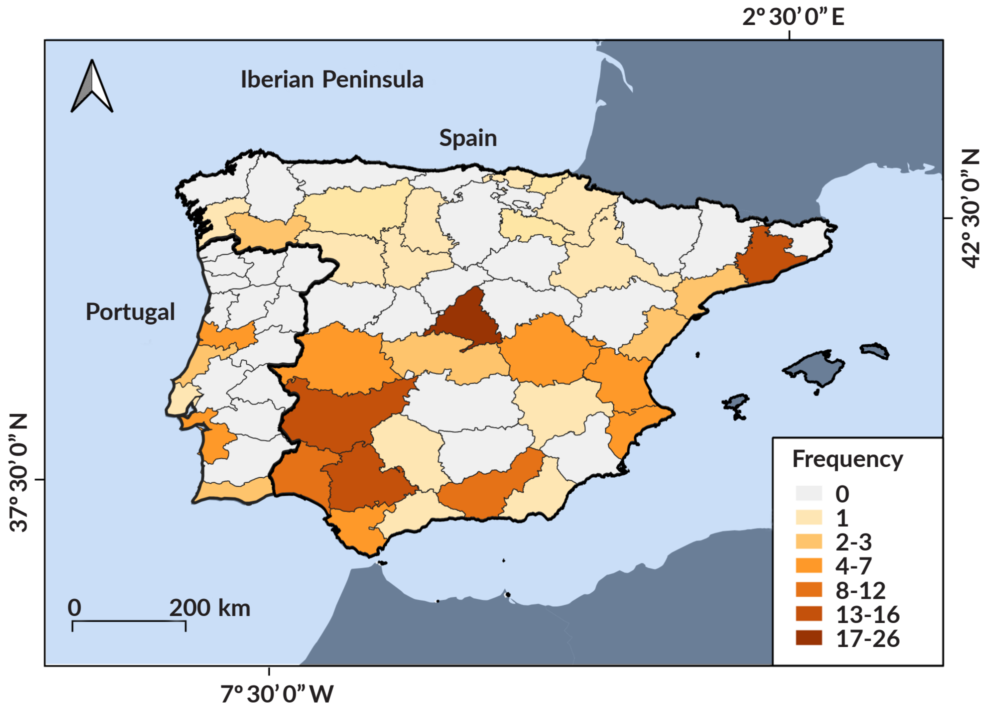

Fig. 3. Map depicting the number of house sparrow studies by Spanish provinces and Portuguese districts in the Iberian Peninsula. The intensity of brown scale indicates the frequency of studies.

Fig. 3. *Mapa que representa el número de estudios de gorrión común por provincias españolas y distritos portugueses en la Península Ibérica. La intensidad de la escala marrón indica la frecuencia de los estudios.*

their distribution across urban land uses (MacGregor-Fors et al 2017). In Spain, house sparrows are particularly abundant in urban-agricultural landscapes with high human activity. They are edge specialists, thriving in urban park edges that provide shelter and food, with lower numbers and breeding densities at interior areas (Fernández-Juricic 2001, Fernandez-Juricic et al 2001b, Murgui 2009). So, small parks and gardens within cities play crucial roles in sustaining their populations (Murgui 2009, Bernat-Ponce et al 2018). However, in invaded areas like Mexico, green areas are less important for the species abundance (MacGregor-Fors et al 2017). Though closely linked to urban environments, they are also widespread in agricultural landscapes, often visiting poultry farms (Sánchez-Cano et al 2024).

Availability for nesting sites also affects house sparrow populations. Insulation and renovation projects transform roofs and leads to the loss of spaces suitable for nesting. However, measures to mitigate such effects have provided sparrows with nesting boxes. Indeed, sparrows frequently dominate nest boxes, outcompeting great tits *Parus major* and Eurasian tree sparrows (Barba and Gil-Delgado 1990, Cordero 1993, Remacha and Delgado 2009). Their diet reflects their habitat preferences, with house sparrows consuming more cereal seeds around human settlements, while Spanish sparrows rely more on weed seeds in agricultural fields (Alonso 1986). Despite dietary overlap, habitat segregation reduces direct competition between these species (Alonso 1986).

However, urbanization and changes in waste management (e.g., replacing surface containers with underground bins) have reduced food availability, particularly in densely built areas (Murgui and Macias 2010, Bernat-Ponce et al 2022). In Valencia city, house sparrow populations dropped by 70% between 1998 and 2008 due to habitat changes linked to urban development (Murgui and Macias 2010). In the orange orchards of Sagunto (Valencia), breeding populations declined from 114 pairs in 1977 to just six in 2001, due to changes in agricultural practices, including the shift from flooding to drip irrigation (Gil-Delgado et al 2002). Notably, across Spain, both House and Eurasian tree sparrow populations have declined, though the latter has shown some urban increases (Ramos-Elvira et al 2023). While reproductive success remains stable, agricultural intensification –such as reduced waste ground and weed seeds– has lowered sparrow densities in non-urban areas (Gil-Delgado et al 2002). Additionally, Mediterranean house sparrows seem to be regionally poorly adapted to cold temperatures and suffer increased mortality in harsh winters (Senar and Copete 1995).

Behavior

Behavior, with 23 published studies (20.2%; all of them in Spain), is the third most researched topic on house sparrows in the Iberian Peninsula. Research has primarily focused on adaptability to urban environments, boldness, social dominance, infanticide, intraspecific brood parasitism, and egg rejection. House sparrows in Spain have shown remarkable behavioral flexibility, nesting in unconventional sites such as moving cranes (Gómez-Serrano 1996) and using human activity as a foraging cue (Fernández-Juricic et al 2003). They have also been shown to adjust their vocalizations to mitigate traffic noise interference (Arroyo-Solís et al 2013). Anti-predator behavior varies by habitat; sparrows in larger urban areas exhibit bolder responses, likely due to systemic habituation, rather than a simple habituation to humans (García-Arroyo et al 2023). Compared to populations from their North American invasion, sparrows in Spain have greater alert distances and take fewer risks (MacGregor-Fors et al 2019, Quesada et al 2022a). In forested urban parks, buffer distances increase with group size but decrease with grass cover, likely due to predator dilution and enhanced food availability (Fernández-Juricic et al 2002). Near pathways, sparrows increase their alert distances in response to human disturbances (Fernández-Juricic et al 2001a).

As highly social and colonial breeders, house sparrows rely on visual cues for dominance and reproduction. Male badge size signals dominance and fitness but may also attract competition, potentially reducing reproductive success (Veiga 1993b, Gonzalez et al 2002). Manipulating badge size influences social interactions, facilitating nest acquisition but possibly imposing survival costs (Veiga 1996b). However, a meta-analysis suggests that while badge size conveys some information, it is not a definitive indicator of dominance (Sánchez-Tójar et al 2018). Sex-based dominance studies in Spain show that females disrupt polygynous males' breeding success by destroying eggs or nestlings, with experienced females outperforming inexperienced ones in fledgling production (Veiga 1990a, Peralta-Sánchez et al 2020). Additionally, house sparrows have shown to outcompete Eurasian tree sparrows *Passer montanus* for nesting sites through aggression, though the tree sparrow counteracts this by delaying egg-laying or using small-entrance nests to block intrusions (Cordero and Senar 1990, 1994).

Infanticide is a common reproductive strategy among Iberian house sparrows, specifically in Spain. Males commit infanticide to ensure their paternity, prompting females to re-lay eggs (Veiga 1990c, 2003). In response, females may delay ovulation and often initiate a new clutch with the replacement male (Veiga 1993a). Dominant females may also commit infanticide to reduce competition and improve the survival of their offspring (Veiga 2004). Egg rejection has evolved as a defense against conspecific brood parasitism. House sparrows in Spain recognize and reject non-mimetic eggs based on spot patterns rather than color (Moreno-Rueda and Soler 2001, López-de-Hierro and Moreno-Rueda 2010). However, rejection rates are low, likely due to the low cost of parasitism at low breeding densities (Soler et al 2011). Notably, high population density does not increase extra-pair fertilization rates, suggesting other factors influence reproductive strategies (Veiga and Boto 2000).

Biology

A review of the 28 studies (24.6%; all of them carried out in Spain) focused on house sparrow biology provides insights into reproduction, morphology, hybridization, and adaptability. In Spain, male badge size has not been found to relate with reproductive success, fledgling numbers, or survival (Veiga 1995). Birkhead et al (1995) found that most unhatched house sparrow eggs result from early embryo mortality or lack of sperm. Hatching asynchrony has been shown to optimize embryo viability under seasonal constraints (Veiga 1992, Veiga and Viñuela 1993), while clutch size, egg viability, and breeding timing are shaped by energetic limitations influencing sibling competition and survival (Veiga 1990b). Extra-pair fertilization has been shown to cluster in early-laid eggs (Cordero et al 1999). Captive studies reveal determinate laying behavior, with population variability (Moreno-Rueda 2004).

Morphological and developmental studies highlight the species' adaptability. Feather growth follows compensatory mechanisms to maintain symmetry and quality (Aparicio 1998, 2001). The uropygial gland aids in feather maintenance, parasite defense, and insulation (Moreno-Rueda 2010c, 2011a, 2014). Molting studies show feather growth rate and barb density influence the process (Alonso 1984, Guallar et al 2021). Research on bone development indicates that limb maturity is reached by the end of the nestling phase (Pulido et al 1996).

Hybridization between house and Eurasian tree sparrows produces intermediates influenced by ecological selection and mate availability, though hybrid fertility remains uncertain (Cordero 1990a, b, 1991, 2002). House-Spanish sparrow hybrids occur at measurable rates, resulting in intermediate phenotypes (Alonso 1985, Cordero and Summers-Smith 1993).

Feeding studies highlight the species' ecological flexibility, including the opportunistic consumption of reptiles and nestlings for protein during breeding (Ayres 2021, Quesada et al 2022b, Rodriguez-Sobreira 2023). Courtship behaviors and mate retention strategies influence reproductive success, with female aggression affecting mate replacement (Veiga 1996a). Rare cases of bilateral gynandromorphism and abnormal feather development underscore the need for continued morphological research (Fernández García 1999, Abella 2002). Finally, hormonal studies link testosterone to badge size, sexual signaling, aggression, and reproduction (Gonzalez et al 2001). These findings highlight the species' adaptability and complex biology in response to environmental and evolutionary pressures.

Health

Health is the most studied house sparrow topic in Spain and the only topic researched in Portugal (41 and 5 papers, 36.0% and 4.4%, respectively). It spans from physiological aspects related to metabolism, immunity, sexual-related traits, anthropogenic impacts, ectoparasites and pathogen effects, detection and transmission.

The immunity of house sparrows interacts with physiological, behavioral, and morpho-sexual traits, suffering seasonal variations. Experimental testosterone treatments during summer alters hematology, increasing erythrocyte numbers, hemoglobin, and plasma protein levels in adults, and leucocytes in juveniles (Puerta et al 1995). In winter, immune response is prioritized over body mass, reflecting seasonal trade-offs (Moreno-Rueda 2011b). Digit ratios, influenced by maternal effects, correlate with sexual traits and immune response, with larger ratios linked to weaker female immunity (Navarro et al 2007). Also, during the first development stages, high nestling begging intensity incurs immune costs, highlighting an energy allocation trade-off (Moreno-Rueda 2010a). Sexual traits like male throat badges, though not costly to produce, require maintenance and reflect body condition (Veiga and Puerta 1996, Gonzalez et al 1999a, Gonzalez et al 1999b). Season influences the relationship of badge size and immunity, with large-badged males showing immune advantages in winter but reduced immunity during breeding (Gonzalez et al 1999a). Wing feathers of Iberian house sparrows are commonly infected by chewing lice (Moreno-Rueda 2005) and feather mites (Behnke et al 1999). However, longer white wing stripes in males signal chewing lice resistance, influencing female mate choice (Moreno-Rueda 2005). Indeed, molt-immunity trade-offs further suggest that plumage traits are a reliably signal to parasite resistance (Moreno-Rueda 2010b).

Despite being urban-dwelling birds, house sparrows face health and physiological challenges due to urbanization pressures. House sparrows adapt physiologically to extreme heat, with evaporative cooling helping to reduce dehydration risks in future heatwaves (Cabello-Vergel et al 2022). Urban individuals experience elevated oxidative stress, reduced antioxidant capacity, higher oxidative damage to lipids and poorer body condition than non-urban conspecifics (Herrera-Dueñas et al 2014, 2017, Jiménez-Peñuela et al 2023). It seems that diet plays a pivotal role in these effects. Experimental urban diets (e.g., bar snacks, pet food) in non-urban individuals worsen health by increasing oxidative stress, anemia, and malnutrition (Bernat-Ponce et al 2023). Moreover, exposure to toxic substances, such as pesticides in deer hunting estates, reduces bird's body condition (Martínez-Haro et al 2007).

Studies have also explored host-pathogen-vector interactions and disease transmission dynamics in the house sparrow, with a particular focus on avian malaria parasites and related haemosporidians. Malaria infections affect avian physiology impairing feather growth (Coon et al 2016) and causing higher oxidative damage to lipids along with lower antioxidant enzyme activity (Jiménez-Peñuela et al 2023). *Plasmodium* and *Haemoproteus* co-infections often have stronger negative fitness effects than single infections, with juveniles showing higher parasitemia than adults (Garcia-Longoria et al 2022). Larger uropygial glands correlate with lower malaria prevalence and better body condition, suggesting an antimicrobial function (Magallanes et al 2016, 2020), indeed, non-urban house sparrows infected with malaria have a smaller uropygial gland volume than their uninfected conspecifics (Magallanes et al 2020). Malaria appears to increase escape behaviors, as infection treatment reduces these responses (Garcia-Longoria et al 2015). Haemosporidian prevalence in house sparrows varies seasonally both in Spain (Neto et al 2020) and Portugal (Ventim et al 2012c) and decreases with increasing latitude (Neto et al 2020). In southern Spain, infection patterns differ by parasite genera (*Plasmodium*, *Haemoproteus*, *Leucocytozoon*), likely influenced by vector communities, climate, and landscape features (Jiménez-Peñuela et al 2021). Plasmodium-infected house sparrows tend to attract more mosquitoes, and the attraction varies with parasite load, supporting the parasite manipulation hypothesis (Yan et al 2018, Díez-Fernández et al 2020b), even uropygial secretions with certain composition may repel them (Yan et al 2018, Díez-Fernández et al 2020a). Anti-malaria treatment reduces infection intensity and increases mosquito survival, with transmission being more effective during chronic infection phases (Gutiérrez-López et al 2019b). Moreover, house sparrow infection status and body mass do not seem to affect mosquito biting rates (Gutiérrez-López et al 2019a). Malaria transmission depends on vector-host community interactions, but global change is expanding parasite distributions, with Iberian house sparrows being infected by *Haemoproteus* (Ventim et al 2012b) and *Plasmodium* lineages (Ferraguti et al 2018, 2019) commonly present in African-migrant species. Moreover, exotic bird species in Portuguese wetlands are found infected by lineages commonly found in house sparrows (Ventim,et al 2012c). The global expansion of house sparrows may partially stem from parasite release according to the *Enemy Release Hypothesis*. Invasive house sparrows in Peru show lower haemosporidian (*Plasmodium* and *Haemoproteus*) prevalence and diversity than Spanish populations (Marzal et al 2018) and similarly, invasive house sparrows in Brazil showed lower prevalence and intensity of infection than Portuguese populations (Antonini et al 2019).

Viruses, including West Nile Virus (WNV), Avipoxvirus (APV), Bagaza Virus (BAGV), and Newcastle Disease Virus (NDV), have also been widely studied in the house sparrow. They are competent WNV hosts, aiding studies on infection dynamics and human transmission (Del Amo et al 2014a, Del Amo et al 2014b, Ferraguti et al 2021a). House sparrows have low WNV antibody prevalence compared to trans-Saharan migrants, suggesting limited local circulation (López et al 2008). WNV seroprevalence in house sparrows correlates with mosquito communities, particularly with *Culex perexiguus* mosquitoes, with enzootic circulation occurring in areas with high *Culex perexiguus* populations and low human densities (Martínez-de la Puente et al 2018, Ferraguti et al 2021a). APV prevalence seems to be moderate (3.2 %) but higher in hatch-year birds than adults (Ruiz-Martínez et al 2016). BAGV experimental infection has caused no mortality or symptoms in house sparrows, with feather sampling aiding early detection (Llorente et al 2015). NDV vaccination elicits strong immune responses, with maternal exposure enhancing offspring immunity but reducing carotenoid levels and antioxidant capacity (Broggi et al 2013, 2016). Additionally, urban house sparrows pose a zoonotic risk, carrying antibiotic-resistant *E. coli* (Sacristán et al 2014) and which presence in poultry farms are raising concerns about pathogen transmission (Sánchez-Cano et al 2024). Finally, the use of the house sparrow as a model species in epidemiology has provided key ecological and evolutionary insights into disease dynamics. It has been used to test the Dilution Effect Hypothesis (DEH), which suggests that higher biodiversity reduces disease transmission. However, urbanization may challenge DEH predictions in the case of vector-borne pathogens (Ferraguti et al 2021b).

Synthesis, challenges, and future directions

In this review, we have synthesized the available peer-reviewed scientific knowledge on the house sparrow in the Iberian Peninsula through published research papers. Regarding publication trends, the number of peer-reviewed articles has increased notably since the mid-1980s. This aligns with the general trend of increasing scientific publications across disciplines (Pacchioni 2018), as observed in other literature reviews (e.g., Barbosa and Moreno 2004, Luna et al 2021, Marín-Gómez and MacGregor-Fors 2021, Murgui 2022b). This trend may be linked to the overall growth of urban ornithology, a relatively new discipline in Spain that emerged in the 1980s. This field has expanded significantly, particularly in the last decade, with studies increasing fourfold compared to the 1980s (Murgui 2022b). Remarkably, 8 % of all urban ornithology studies in Spain focus on this species, potentially contributing to the observed publication pattern (Murgui 2022b).

Notably, most studies on house sparrows in the Iberian Peninsula are observational field studies (41.2 %), essential for understanding the species' biology, ecology, and health in the wild. However, the house sparrow has also been widely used as an experimental model (Hanson et al 2020), both in laboratory and field settings. Markedly, almost 15 % of the assessed studies were conducted using captive populations, allowing for controlled condition research. Geographically, Iberian research is concentrated in Spain, specifically in the provinces of Madrid (center), Barcelona (northeast), Seville (south), and Badajoz (west), each with at least 15 scientific papers. However, in Portugal, most studies were carried out in Coimbra (center) and Setúbal (southwest) districts with 4 of the 5 research papers. This likely reflects the presence of individual researchers, research groups, or institutions with long-term studies on the species. For example, 15 papers on house sparrows were published in Madrid (1990–2004), nine in Barcelona (1990–2002), and 11 in Seville (2008–2021). However, this distribution does not necessarily indicate that these locations are more suitable for research but rather reflects long-term study efforts in specific areas, led by J. P. Veiga, P. J. Cordero, and J. Figuerola, respectively. In Portugal, three out of five selected studies were carried out by R. Ventim and her team, focused on parasitism. Similarly, the dominance of studies on health, biology, and behavior likely corresponds to the research focus of these groups. Veiga's work mainly addressed the species' biology (e.g., infanticide, signaling, and hatching asynchrony), while Figuerola's research group specialized in host-pathogens interactions (e.g., avian malaria, West Nile Virus and disease dynamics), using house sparrows as a model species.

Our review of 114 scientific papers identified several research gaps, particularly in conservation, where the lack of attention is striking in this region. This may be due to the species' decline occurring primarily in cities, while urban ecology in Spain has only recently gained research momentum in the past decade (Murgui 2022b). Despite this, slightly more than half (50.9 %) of house sparrow studies in the Iberian Peninsula have been conducted in urbanized areas, focusing on the effects of urban life and physiological adaptations rather than direct conservation concerns (Herrera-Dueñas et al 2017, Jiménez-Peñuela et al 2021, Bernat-Ponce et al 2023). Furthermore, despite evidence of the species' decline in non-urban Spain since the early 2000s, we identified no trigger in the number of scientific publications focusing on how conservation measures, neither local nor regional, have affected species numbers. It is noteworthy that all the studies from Portugal focused exclusively on health-related aspects, revealing a major knowledge gap on the species' behavior, ecology, conservation, and general biology in the western part of the Iberian Peninsula.

Another research gap is the absence of scientific reviews summarizing studies on sparrows (genus *Passer*), as single-species bird reviews are rare in Spain or Portugal. We found only one comparable review on the woodcock *Scolophax rusticola* (Arizaga 2013), which covers biological, ecological, and health topics similarly to our study. In Europe, existing house sparrow reviews focus on population status in northwestern regions (United Kingdom, Belgium, Ireland and Germany) (De Laet and Summers-Smith 2007) and species decline (Summers-Smith 2003, Shaw et al 2008, Bell et al 2010). Comprehensive knowledge of the house sparrow is primarily found in specialized books or book chapters (Summers-Smith 1963, 1988, 2009, Anderson 2006), despite it being the sixth most extensively studied bird species worldwide (Ducatez and Lefebvre 2014).

Future research on house sparrows in the Iberian Peninsula could focus on key areas that not only provide crucial information but also open new research avenues. First, large-scale population studies are lacking at both national and regional levels, with only a few exceptions (Gil-Delgado et al 2002, Murgui 2022a, Ramos-Elvira et al 2023). Understanding the distinct population trends of urban and non-urban populations is essential for identifying threats and implementing conservation measures. Additionally, more research on Iberian sparrows is needed to compare with existing studies on house sparrows, clarifying their taxonomical limits, coexistence, competition, and potential hybridization. Lastly, improved communication among Iberian researchers interested in *Passer* species would greatly benefit collaboration and knowledge advancement, particularly in establishing standardized census methodologies and undertaking large-scale population studies. We hope that this review, beyond synthesizing existing knowledge and providing an overview of the peer-reviewed research to date, will spark a new wave of curiosity about the species and contribute to a surge in scientific interest across the Iberian Peninsula. The house sparrow is not only a fascinating model organism but also a commensal species, one that has shared our spaces, our cities, and even our daily lives for centuries. Perhaps it is time we strive to understand it better and, if needed, ensure its future alongside ours.

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E Bernat-Ponce, conceptualization, data curation, formal analysis, investigation, methodology, project administration, validation, visualization, writing-original draft, writing-review and editing; **Á Luna,** conceptualization, investigation, methodology, validation, writing-original draft, writing-review and editing; **J Jiménez-Peñuela,** conceptualization, investigation, methodology, validation, writing-original draft, writing-review and editing; **I MacGregor-Fors,** conceptualization, investigation, methodology, project administration, resources, supervision, validation, visualization, writing-original draft, writing-review and editing. All authors read and approved the final manuscript.

Conflicts of interest
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Supplementary Material

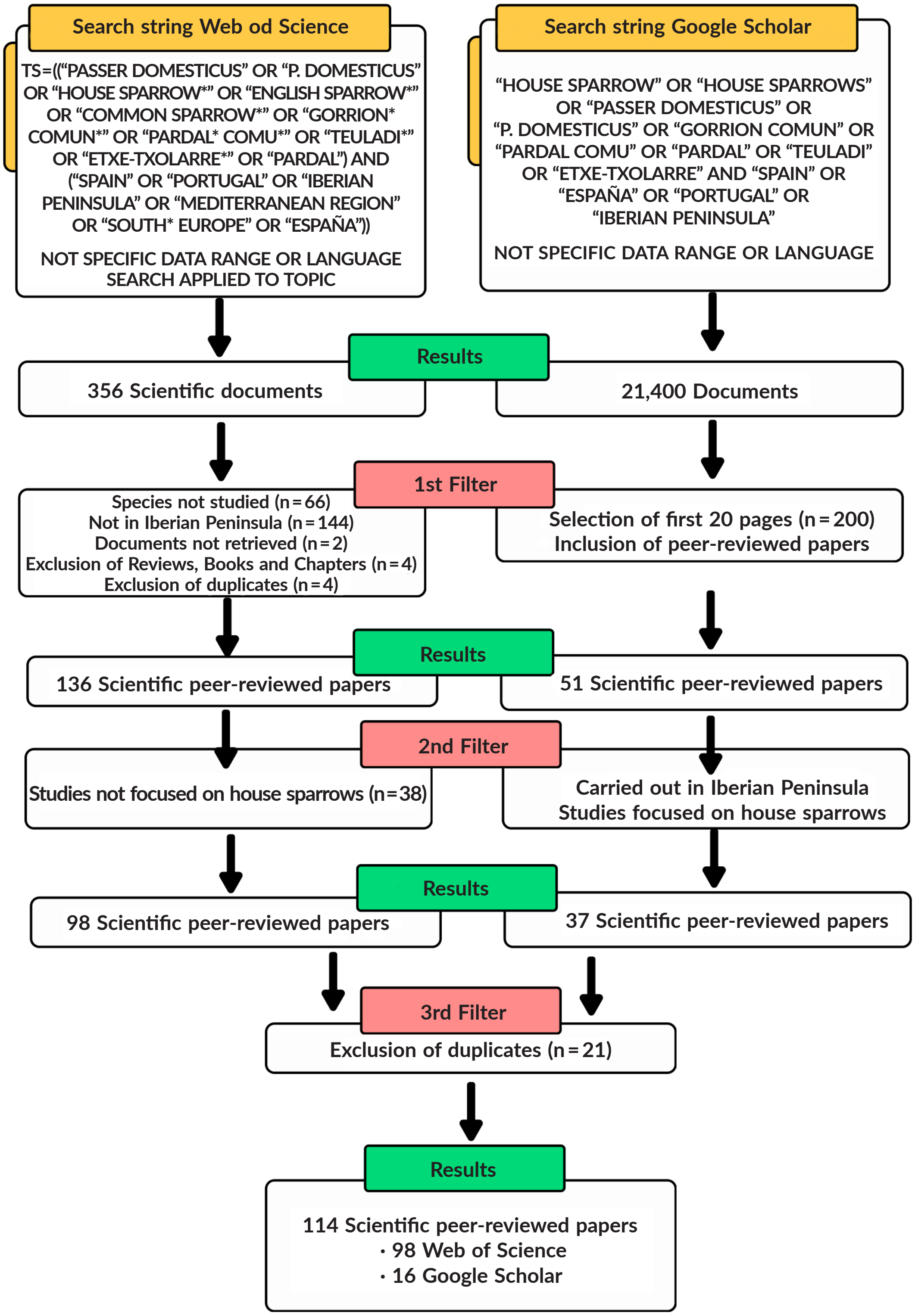

Fig. S1. Flow diagram illustrating the sequential steps undertaken in the house sparrow knowledge review process, including the descriptive results.

Fig. S1. *Diagrama de flujo que ilustra los pasos secuenciales emprendidos en el proceso de revisión de los conocimientos sobre el gorrión común, incluidos los resultados descriptivos.*

Table S1. Summary of the extracted information and categories of main topic, study type, and study habitat for the selected papers in the house sparrow literature review.

Tabla S1. *Resumen de la información extraída y categorías de tema principal, tipo de estudio y hábitat de estudio para los artículos seleccionados en la revisión bibliográfica del gorrión común.*

Variable	Category	Description
Main topic	Behavior	It encompasses various aspects of house sparrow behavior and how they interact with their environment, conspecifics and each other species, including alert distances, flight distances, risk-taking behavior, infanticide, sexual conflict, adaptation capacity, and signaling status.
	Biology	Studies of biological aspects of house sparrows, such as anatomy, moult, development, general genetics, hybridization, taxonomy, reproduction, broods, clutch size, and hatching synchrony.
	Conservation	Studies about those factors affecting their populations, conservationist initiatives and main concerns regarding the conservation of the species, such as land use change.
	Ecology	Topic that covers ecological aspects, such as population trends, seasonal changes/patterns, annual cycle patterns, breeding phenology, spatial segregation, and studies of factors that determine their abundance or density.
	Health	Studies related to genetics, parasitism, immunity, infection rates, physiology, and toxicology. It also covers studies where the house sparrow has been used as a model species in health research.
Study type	Observational field / Correlational field	Studies where free-ranging wild birds have been observed in their natural habitat without experimental manipulation of any kind (e.g. observational studies reporting naturalistic descriptions or focused on relationships between house sparrows and environmental variables) or studies where birds have been trapped, ringed, measured in the field or observed in nest boxes but without any experimental approach (e.g. pair identification).
	Experimental field	Research where free-ranging wild birds have undergone an experimental approach without moving them to aviaries in the field; these include studies carried out in nest-boxes (e.g., food selection, nest-box competition, egg removal) and capture-recapture.
	Observational lab	Studies where birds have been captured in the wild, but also with individuals in captivity (including breeding), to obtain tissue samples (e.g., blood, plasma) to study infection rates, identify parasites, or quantify biochemical parameters, among other things, from a descriptive/correlational approach but without an experimental approach. This category also includes studies on museum specimens (e.g., measurement) or modelization works (construction of statistical models) with the species.
	Experimental captivity lab	Works carried out with captive birds that underwent an experimental approach assessing the effect of a controlled variable (e.g., diet, infection, selection experiment).
Study site	Urban (City)	Large urbanized areas characterized by a high population density and a concentration of industries, services, financial centers, and technology hubs.
	Urban (Town)	Smaller urban settlements with lower population densities, often defined by a local economy based on agriculture, tourism, or small industries.
	Agricultural	Areas primarily dedicated to agricultural and livestock production, typically located in rural environments. This category includes the different crops (olive groves, vineyards, and orchards) and different livestock farms (poultry and cattle, equine, or swine farms).
	Natural environments	Areas dominated by native vegetation, including forests, shrublands, grasslands, wetlands, and other non-urbanized and non-agricultural ecosystems.
	Captivity	Individuals from a captive population.

Table S2. Brief summary of 114 reviewed papers on house sparrow research in the Iberian Peninsula, organized by topic. Information about the Topic, Study location, Study type and Habitat can be found at Supplementary Table 1. The "Database" column refers to the source from which each paper was obtained, either Web of Science (WoS) or Google Scholar (GS). NA means that information was not available.

***Tabla S2.** Breve resumen de 114 artículos revisados sobre la investigación del gorrión común en la Península Ibérica, organizados por temas. La información sobre el tema, la localización del estudio, el tipo de estudio y el hábitat se puede encontrar en la Tabla Suplementaria 1. La columna «Base de datos» se refiere a la fuente de la que se obtuvo cada artículo, ya sea Web of Science (WoS) o Google Scholar (GS). NA significa que la información no estaba disponible.*

	Reference	Topic	Study location	Study type	Habitat	Database
1	Arroyo-Solís A, Castillo JM, Figueroa E, López-Sánchez JL, Slabbekoorn H, 2013. Experimental evidence for an impact of anthropogenic noise on dawn chorus timing in urban birds. *Journal of Avian Biology* 44, 288-296. DOI: 10.1111/j.1600-048X.2012.05796.x	Behavior	Seville	Experimental field	Urban (City)	WoS
2	Cordero PJ, Senar JC, 1990. Interspecific nest defence in European sparrows: different strategies to deal with a different species of opponent? *Ornis Scandinavica* 21, 71. DOI: 10.2307/3676381	Behavior	Barcelona	Experimental field	Urban (Town); Agricultural	WoS
3	Cordero PJ, Senar JC, 1994. Persistent tree sparrows *Passer montanus* can counteract house sparrow *P. domesticus* competitive pressure. *Bird Behavior* 10, 7-13. DOI: 10.3727/015613894791748980	Behavior	Barcelona	Experimental field	Agricultural	GS
4	Fernández-Juricic E, Jimenez MD, Lucas E, 2001b. Alert distance as an alternative measure of bird tolerance to human disturbance: implications for park design. *Environmental Conservation* 28, 263-269. DOI: 10.1017/S0376892901000273	Behavior	Madrid	Observational field	Urban (City)	WoS
5	Fernández-Juricic E, Jimenez MD, Lucas E, 2002. Factors affecting intra- and inter-specific variations in the difference between alert distances and flight distances for birds in forested habitats. *Canadian Journal of Zoology* 80, 1212-1220. DOI: 10.1139/z02-104	Behavior	Madrid	Observational field	Urban (City)	WoS
6	Fernández-Juricic E, Sallent A, Sanz R, RodrÍguez-Prieto I, 2003. Testing the Risk-Disturbance Hypothesis in a Fragmented Landscape: Nonlinear Responses of house sparrows to Humans. *The Condor* 105, 316-326. DOI: 10.1093/condor/105.2.316	Behavior	Madrid	Experimental field; Observational field	Urban (City)	WoS
7	García-Arroyo M, MacGregor-Fors I, Quesada J, Borràs A, Colomé-Menoyo L, Senar JC, 2023. House sparrow (*Passer domesticus*) escape behavior is triggered faster in smaller settlements. *Scientific Reports* 13, 2545. DOI: 10.1038/s41598-022-26988-0	Behavior	Barcelona	Observational field	Urban (City); Urban (Town)	WoS
8	Gómez-Serrano MA, 1996. Nidificación de gorrión común *Passer domesticus* en una grúa móvil. *Butlletí Del Grup Català d'Anellament* 13, 65-66.	Behavior	Castellón	Observational field	Urban (City)	WoS
9	Gonzalez G, Sorci G, Smith LC, De Lope F, 2002. Social control and physiological cost of cheating in status signalling male house sparrows (*Passer domesticus*). *Ethology* 108, 289-302. DOI: 10.1046/j.1439-0310.2002.00779.x	Behavior	Badajoz	Experimental lab; Observational lab	NA	WoS
10	López-de-Hierro MDG, Moreno-Rueda G, 2010. Egg-spot pattern rather than egg colour affects conspecific egg rejection in the house sparrow (*Passer domesticus*). *Behavioral Ecology and Sociobiology* 64, 317-324. DOI: 10.1007/s00265-009-0811-9	Behavior	Granada	Experimental lab	Captivity	GS
11	MacGregor-Fors I, Quesada J, Lee JG-H, Yeh PJ, 2019. On the lookout for danger: house sparrow alert distance in three cities. *Urban Ecosystems* 22, 955-960. DOI: 10.1007/s11252-019-00874-6	Behavior	Barcelona	Observational field	Urban (City)	WoS
12	Moreno-Rueda G, Soler M, 2001. Reconocimiento de huevos en el gorrión común *Passer domesticus*, una especie con parasitismo de cría intraespecífico. *Ardeola* 48, 225-231.	Behavior	NA	Experimental lab	Captivity	GS
13	Peralta-Sánchez JM, Colmenero J, Redondo-Sánchez S, Ontanilla J, Soler M, 2020. Females are more determinant than males in reproductive performance in the house sparrow *Passer domesticus. Journal of Avian Biology* 51, e02240. DOI: 10.1111/jav.02240	Behavior	Granada	Experimental lab	Captivity	GS
14	Quesada J, Chávez-Zichinelli CA, García-Arroyo M, Yeh PJ, Guevara R, Izquierdo-Palma J, MacGregor-Fors I, 2022a. Bold or shy? Examining the risk-taking behavior and neophobia of invasive and non-invasive house sparrows. *Animal Biodiversity and Conservation* 45, 97-106. DOI: 10.32800/abc.2022.45.0097	Behavior	Barcelona	Experimental lab	Urban (City); Agricultural	WoS
15	Soler M, Ruiz-Castellano C, Fernández-Pinos MDC, Rösler A, Ontanilla J, Pérez-Contreras T, 2011. House sparrows selectively eject parasitic conspecific eggs and incur very low rejection costs. *Behavioral Ecology and Sociobiology* 65, 1997-2005. DOI: 10.1007/s00265-011-1209-z	Behavior	Granada	Experimental lab	Captivity	GS
16	Veiga JP, 1990a. Sexual conflict in the house sparrow: interference between polygynously mated females versus asymmetric male investment. *Behavioral Ecology and Sociobiology* 27, 345-350. DOI: 10.1007/BF00164005	Behavior	Madrid	Observational field	Natural environments	WoS
17	Veiga JP, 1990c. Infanticide by male and female house sparrows. *Animal Behaviour* 39, 496-502. DOI: 10.1016/S0003-3472(05)80414-2	Behavior	Madrid	Observational field	Natural environments	WoS

Table S2. (Cont.)

	Reference	Topic	Study location	Study type	Habitat	Database
18	Veiga JP, 1993a. Prospective infanticide and ovulation retardation in free-living house sparrows. *Animal Behaviour* 45, 43-46. DOI: 10.1006/anbe.1993.1005	Behavior	Madrid	Observational field	Natural environments	WoS
19	Veiga JP, 1993b. Badge size, phenotypic quality, and reproductive success in the house sparrow: a study on honest advertisement. *Evolution* 47, 1161. DOI: 10.2307/2409982	Behavior	Madrid	Experimental field; Observational field	Natural environments	WoS
20	Veiga JP, 1996b. Permanent exposure versus facultative concealment of sexual traits: an experimental study in the house sparrow. *Behavioral Ecology and Sociobiology* 39, 345-352. DOI: 10.1007/s002650050299	Behavior	Madrid	Experimental field; Observational field	Natural environments	WoS
21	Veiga JP, 2003. Infanticide by male house sparrows: gaining time or manipulating females? *Proceedings of the Royal Society of London Series B: Biological Sciences* 270, 87-89. DOI: 10.1098/rsbl.2003.0027	Behavior	Madrid	Observational field	Natural environments	WoS
22	Veiga JP, 2004. Replacement female house sparrows regularly commit infanticide: gaining time or signaling status? *Behavioral Ecology* 15, 219-222. DOI: 10.1093/beheco/arh003	Behavior	Madrid	Observational field	Natural environments	WoS
23	Veiga JP, Boto L. 2000. Low frequency of extra-pair fertilisations in house sparrows breeding at high density. *Journal of Avian Biology* 31, 237-244.	Behavior	Madrid	Observational field	Natural environments	GS
24	Abella JC, 2002. Capture of two probable gynandromorphic house sparrows *Passer domesticus* in NE Spain. *Revista Catalana d'Ornitologia* 19, 25-29.	Biology	Tarragona	Observational field	Natural environments	WoS
25	Alonso JC, 1984. Zur Mauser spanischer Weiden- und Haussperlinge (*Passer hispaniolensis* und *domesticus*). *Journal für Ornithologie* 125, 209-223. DOI: 10.1007/BF01640589	Biology	Cáceres	Observational field	Urban (Town)	WoS
26	Alonso JC, 1985. Description of intermediate phenotypes between *Passer hispaniolensis* and *Passer domesticus*. *Ardeola* 32, 31-38.	Biology	Cáceres; Toledo; Madrid; Almería; Seville; Huelva	Observational lab; Experimental field	NA	GS
27	Aparicio J, 1998. Patterns of fluctuating asymmetry in developing primary feathers: a test of the compensational growth hypothesis. *Proceedings of the Royal Society of London Series B: Biological Sciences* 265, 2353-2357. DOI: 10.1098/rspb.1998.0583	Biology	Cuenca	Experimental lab	Agricultural	WoS
28	Aparicio JM, 2001. Patterns of growth and fluctuating asymmetry: the effects of asymmetrical investment in traits with determinate growth. *Behavioral Ecology and Sociobiology* 49, 273-282. DOI: 10.1007/s002650000302	Biology	Cuenca	Observational lab	Agricultural	WoS
29	Ayres C, 2021. Predation on a Bocage's wall lizard (*Podarcis bocagei*) by a house sparrow (*Passer domesticus*). *Reptiles and Amphibians* 28, 420. DOI: 10.17161/randa.v28i3.15731	Biology	Pontevedra	Observational field	Urban (City)	WoS
30	Birkhead TR, Veiga JP, Fletcher F, 1995. Sperm competition and unhatched eggs in the house sparrow. *Journal of Avian Biology* 26, 343-345. DOI: 10.2307/3677051	Biology	Madrid	Observational lab; Experimental field	NA	WoS
31	Cordero PJ, 1990a. Phenotypes of juvenile offspring of a mixed pair consisting of a male house sparrow and a female tree sparrow *Passer* spp. 67, 52-56.	Biology	Barcelona	Observational lab	NA	WoS
32	Cordero PJ, 1990b. Breeding success and behaviour of a pair of House and tree sparrow (*Passer domesticus*, *Passer montanus*) in the wild. *Journal Für Ornithologie* 131, 165-167. DOI: 10.1007/BF01647138	Biology	Barcelona	Observational field	Agricultural	WoS
33	Cordero PJ, 1991. Phenotypes of adult house sparrow *Passer domesticus* and tree sparrow *Passer montanus*. *Bulletin of the British Ornithological Club* 111, 44-46.	Biology	Barcelona	Observational lab	NA	GS
34	Cordero PJ, 2002. Hybrids fertility or intraspecific extra-pair fertilisations in mixed pairs of house and tree sparrows? *International Studies on Sparrows* 29, 5-110.	Biology	Barcelona	Observational field	Urban (City)	WoS
35	Cordero PJ, Summers-Smith JD, 1993. Hybridization between House and tree sparrow (*Passer domesticus*, *P. montanus*). *Journal Für Ornithologie* 134, 69-77. DOI: 10.1007/BF01661134	Biology	Barcelona	Observational field	Natural environments	WoS
36	Cordero PJ, Wetton JH, Parkin DT, 1999. Within-clutch patterns of egg viability and paternity in the house sparrow. *Journal of Avian Biology* 30, 103-107. DOI: 10.2307/3677249	Biology	Barcelona	Observational lab; Experimental field	Agricultural	WoS
37	Fernández García JM, 1999. An extra primary feather and abnormal sequence of primary moult in a house sparrow *Passer domesticus*. *Butlletí del Grup Català d'Anellament* 16, 23-25.	Biology	León	Observational field	Urban (Town)	WoS
38	Gonzalez G, Sorci G, Smith LC, Lope F, 2001. Testosterone and sexual signalling in male house sparrows (*Passer domesticus*). *Behavioral Ecology and Sociobiology* 50, 557-562. DOI: 10.1007/s002650100399	Biology	Badajoz	Experimental lab	NA	WoS
39	Guallar S, Carrillo-Ortiz J, Quesada J, 2021. Marginal-covert moult in the house sparrow *Passer domesticus*. *Ringing and Migration* 36, 95-104. DOI: 10.1080/03078698.2022.2100455	Biology	Barcelona	Observational field	Urban (City)	WoS

Table S2. (Cont.)

	Reference	Topic	Study location	Study type	Habitat	Database
40	Moreno-Rueda G, 2004. Is the house sparrow Passer domesticus an indeterminate or a determinate layer? *Ardeola* 51, 441-444.	Biology	Granada	Experimental lab	Captivity	WoS
41	Moreno-Rueda G, 2010c. Uropygial gland size correlates with feather holes, body condition and wingbar size in the house sparrow *Passer domesticus*. *Journal of Avian Biology* 41, 229-236. DOI: 10.1111/j.1600-048X.2009.04859.x	Biology	Granada	Experimental lab; Observational lab	Captivity	WoS
42	Moreno-Rueda G, 2011a. House sparrows *Passer domesticus* with larger uropygial glands show reduced feather wear. *Ibis* 153, 195-198. DOI: 10.1111/j.1474-919X.2010.01082.x	Biology	Granada	Observational lab	Captivity	GS
43	Moreno-Rueda G, 2014. Uropygial gland size, feather holes and moult performance in the house sparrow *Passer domesticus*. *Ibis* 156, 457-460. DOI: 10.1111/ibi.12131	Biology	Granada	Observational lab	Agricultural	GS
44	Pulido JC, García M, Muñoz A, 1996. Crecimiento óseo de los miembros en el gorrión común *Passer domesticus* (L., 1758). *Miscel·lània Zoològica* 19, 35-42.	Biology	Badajoz	Observational lab	Natural environments	WoS
45	Quesada J, Pàmies E, Oliver C, MacGregor-Fors I, 2022b. Hunter sparrows: a predation record of a house sparrow on Kentish plover nestlings. *Revista Catalana d'Ornitologia* 37-42. DOI: 10.62102/20.8100.01.38	Biology	Tarragona	Observational field	Natural environments	GS
46	Rodriguez-Sobreira D, 2023. Predation attempt on a slow worm (*Anguis fragilis*) by a house sparrow (*Passer domesticus*). *Reptiles and Amphibians* 30, e15973. DOI: 10.17161/randa.v30i1.15973	Biology	Ourense	Observational field	Urban (Town)	WoS
47	Veiga JP, 1990b. A comparative study of reproductive adaptations in house and tree sparrows. *The Auk* 107, 45-59.	Biology	Madrid	Observational field	Natural environments	WoS
48	Veiga JP, 1992. Hatching asynchrony in the house sparrow: a test of the Egg-Viability Hypothesis. *The American Naturalist* 139, 669-675. DOI: 10.1086/285351	Biology	Madrid	Experimental field	Natural environments	WoS
49	Veiga JP, 1995. Honest signaling and the survival cost of badges in the house sparrow. *Evolution* 49, 570. DOI: 10.2307/2410281	Biology	Madrid	Experimental field	Natural environments	WoS
50	Veiga JP, 1996a. Mate replacement is costly to males in the multibrooded house sparrow: an experimental study. *The Auk* 113, 664-671. DOI: 10.2307/4088987	Biology	Madrid	Experimental field; Observational field	Natural environments	WoS
51	Veiga JP, Viñuela J, 1993. Hatching asynchrony and hatching success in the house sparrow: evidence for the Egg Viability Hypothesis. *Ornis Scandinavica* 24, 237. DOI: 10.2307/3676739	Biology	Madrid	Experimental field	Natural environments	WoS
52	Balmori A, Hallberg Ö, 2007. The urban decline of the house sparrow (*Passer domesticus*): a possible link with electromagnetic radiation. *Electromagnetic Biology and Medicine* 26, 141-151. DOI: 10.1080/15368370701410558	Conservation	Valladolid	Observational field	Urban (City)	WoS
53	Bernat-Ponce E, Gil-Delgado JA, López-Iborra GM, 2020. Replacement of semi-natural cover with artificial substrates in urban parks causes a decline of house sparrows *Passer domesticus* in Mediterranean towns. *Urban Ecosystems* 23, 471-481. DOI: 10.1007/s11252-020-00940-4	Conservation	Valencia; Alicante	Observational field	Urban (City); Urban (Town)	WoS
54	Bernat-Ponce E, Gil-Delgado JA, López-Iborra GM, 2021. Recreational noise pollution of traditional festivals reduces the juvenile productivity of an avian urban bioindicator. *Environmental Pollution* 286, 117247. DOI: 10.1016/j.envpol.2021.117247	Conservation	Valencia; Alicante	Observational field	Urban (Town)	WoS
55	Alonso JC, 1986. Ecological segregation between sympatric Spanish sparrows (*Passer hispaniolensis* Temm.) and house sparrows (*Passer domesticus* (L.)) during winter. *Ekologia Polska* 34, 63-73.	Ecology	Seville	Observational lab	Agricultural	WoS
56	Barba E, Gil-Delgado JA, 1990. Competition for nest-boxes among four vertebrate species: an experimental study in orange groves. *Ecography* 13, 183-186. DOI: 10.1111/j.1600-0587.1990.tb00606.x	Ecology	Valencia	Experimental field	Agricultural	WoS
57	Bernat-Ponce E, Gil-Delgado JA, Guijarro D, 2018. Factors affecting the abundance of house sparrows *Passer domesticus* in urban areas of southeast of Spain. *Bird Study* 65, 404-416. DOI: 10.1080/00063657.2018.1518403	Ecology	Alicante	Observational field	Urban (City); Urban (Town)	WoS
58	Bernat-Ponce E, Ferrer D, Gil-Delgado JA, López-Iborra GM, 2022. Effect of replacing surface with underground rubbish containers on urban house sparrows *Passer domesticus*. *Urban Ecosystems* 25, 121-132. DOI: 10.1007/s11252-021-01138-y	Ecology	Valencia; Alicante	Observational field	Urban (City); Urban (Town)	WoS
59	Cordero PJ, 1993. Factors influencing numbers of syntopic house sparrows and Eurasian tree sparrows on farms. *The Auk* 110, 382-385.	Ecology	Barcelona	Observational field	Agricultural; Natural environments	WoS
60	Fernandez-Juricic E, Sanz R, Sallent A, 2001a. Frequency-dependent predation by birds at edges and interiors of woodland. *Biological Journal of the Linnean Society* 73, 43-49. DOI: 10.1006/bijl.2001.0522	Ecology	Madrid	Experimental field	Urban (City)	WoS

Table S2. (Cont.)

	Reference	Topic	Study location	Study type	Habitat	Database
61	Gil-Delgado JA, Vives-Ferrándiz C, Tapiero A, 2002. Tendencia decreciente de una población de gorrión común *Passer domesticus* en los naranjales del este de España. *Ardeola* 49, 195-209.	Ecology	Valencia	Observational field	Agricultural	WoS
62	MacGregor-Fors I, Quesada J, Lee JG-H, Yeh PJ, 2017. Space invaders: house sparrow densities along three urban-agricultural landscapes. *Avian Conservation and Ecology* 12, 11. DOI: 10.5751/ACE-01082-120211	Ecology	Barcelona	Observational field	Urban (City); Agricultural	WoS
63	Murgui E, 2009. Seasonal patterns of habitat selection of the house sparrow *Passer domesticus* in the urban landscape of Valencia (Spain). *Journal of Ornithology* 150, 85-94. DOI: 10.1007/s10336-008-0320-z	Ecology	Valencia	Observational field	Urban (City); Agricultural	WoS
64	Murgui E, Macias A, 2010. Changes in the house sparrow *Passer domesticus* population in Valencia (Spain) from 1998 to 2008. *Bird Study* 57, 281-288. DOI: 10.1080/00063651003716762	Ecology	Valencia	Observational field	Urban (City); Agricultural	WoS
65	Ramos-Elvira E, Banda E, Arizaga J, Martín D, Aguirre JI, 2023. Long-term population trends of house sparrow and Eurasian tree sparrow in Spain. *Birds* 4, 159-170. DOI: 10.3390/birds4020013	Ecology	Seville; Madrid; Castellón; Toledo; Vizcaya; La Rioja; Guipúzcoa; Cuenca; Zaragoza; Navarra; Palencia; Málaga; Córdoba; Zamora	Observational field	Urban (City); Urban (Town); Natural environments	WoS
66	Remacha C, Delgado JA, 2009. Spatial nest-box selection of cavity-nesting bird species in response to proximity to recreational infrastructures. *Landscape and Urban Planning* 93, 46-53. DOI: 10.1016/j.landurbplan.2009.06.004	Ecology	Madrid	Experimental field	Natural environments	WoS
67	Sánchez-Cano A, Camacho M-C, Ramiro Y, Cardona-Cabrera T, Höfle U, 2024. Seasonal changes in bird communities on poultry farms and house sparrow—wild bird contacts revealed by camera trapping. *Frontiers in Veterinary Science* 11, 1369779. DOI: 10.3389/fvets.2024.1369779	Ecology	Toledo; Cuenca; Albacete	Observational field	Agricultural	WoS
68	Senar JC, Copete JL, 1995. Mediterranean house sparrows (*Passer domesticus*) are not used to freezing temperatures: An analysis of survival rates. *Journal of Applied Statistics* 22, 1069-1074. DOI: 10.1080/02664769524829	Ecology	Barcelona	Observational field	Agricultural; Natural environments	WoS
69	Antonini Y, Lobato DNC, Norte AC, Ramos JA, Moreira PDA, Braga EM, 2019. Patterns of avian malaria in tropical and temperate environments: testing the 'The enemy release hypothesis'. *Biota Neotropica* 19, e20180716. DOI: 10.1590/1676-0611-bn-2018-0716	Health	Coimbra (Portugal)	Observational field, Observational lab	NA	WoS
70	Behnke J, McGregor P, Cameron J, Hartley I, Shepherd M, Gilbert F, Barnard C, Hurst J, Gray S, Wiles R, 1999. Semi-quantitative assessment of wing feather mite (Acarina) infestations on passerine birds from Portugal. Evaluation of the criteria for accurate quantification of mite burdens. *Journal of Zoology* 248, 337-347. DOI: 10.1111/j.1469-7998.1999.tb01033.x	Health	Setúbal; Lisboa (Portugal)	Observational field, Observational lab	NA	WoS
71	Bernat-Ponce E, Gil-Delgado JA, Guardiola JV, López-Iborra GM, 2023. Eating in the city: Experimental effect of anthropogenic food resources on the body condition, nutritional status, and oxidative stress of an urban bioindicator passerine. *Journal of Experimental Zoology Part A: Ecological and Integrative Physiology* 339, 803-815. DOI: 10.1002/jez.2730	Health	Alicante	Experimental lab	Agricultural	WoS
72	Broggi J, García O, Miranda F, Pagès A, Soriguer RC, Figuerola J, 2013. Immune response to Newcastle Disease Virus vaccination in a wild passerine. *Journal of Wildlife Diseases* 49, 1004-1008. DOI: 10.7589/2012-10-266	Health	Seville	Experimental lab	Captivity	WoS
73	Broggi J, Soriguer RC, Figuerola J, 2016. Transgenerational effects enhance specific immune response in a wild passerine. *PeerJ* 4, e1766. DOI: 10.7717/peerj.1766	Health	Seville	Experimental field	Agricultural; Natural environments	WoS
74	Cabello-Vergel J, González-Medina E, Parejo M, Abad-Gómez JM, Playà-Montmany N, Patón D, Sánchez-Guzmán JM, Masero JA, Gutiérrez JS, Villegas A, 2022. Heat tolerance limits of Mediterranean songbirds and their current and future vulnerabilities to temperature extremes. *Journal of Experimental Biology* 225, jeb244848. DOI: 10.1242/jeb.244848	Health	Badajoz	Experimental lab	Agricultural; Natural environments	WoS
75	Coon CAC, Garcia-Longoria L, Martin LB, Magallanes S, De Lope F, Marzal A, 2016. Malaria infection negatively affects feather growth rate in the house sparrow *Passer domesticus*. *Journal of Avian Biology* 47, 779-787. DOI: 10.1111/jav.00942	Health	Badajoz	Experimental lab	Urban (City)	WoS

Table S2. (Cont.)

	Reference	Topic	Study location	Study type	Habitat	Database
76	Del Amo J, Llorente F, Figuerola J, Soriguer RC, Moreno AM, Cordioli P, Weissenböck H, Jiménez-Clavero MÁ, 2014a. Experimental infection of house sparrows (*Passer domesticus*) with West Nile virus isolates of Euro-Mediterranean and North American origins. *Veterinary Research* 45, 33. DOI: 10.1186/1297-9716-45-33	Health	Seville	Experimental lab	Captivity	WoS
77	Del Amo J, Llorente F, Pérez-Ramirez E, Soriguer RC, Figuerola J, Nowotny N, Jiménez-Clavero MA, 2014b. Experimental infection of house sparrows (*Passer domesticus*) with West Nile virus strains of lineages 1 and 2. *Veterinary Microbiology* 172, 542-547. DOI: 10.1016/j.vetmic.2014.06.005	Health	Seville	Experimental lab	Captivity	WoS
78	Díez-Fernández A, Martínez-de la Puente J, Gangoso L, Ferraguti M, Soriguer R, Figuerola J, 2020a. House sparrow uropygial gland secretions do not attract ornithophilic nor mammophilic mosquitoes. *Medical and Veterinary Entomology* 34, 225-228. DOI: 10.1111/mve.12401	Health	Huelva; Cádiz; Seville	Experimental lab	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
79	Díez-Fernández A, Martínez-de la Puente J, Gangoso L, López P, Soriguer R, Martín J, Figuerola J, 2020b. Mosquitoes are attracted by the odour of Plasmodium-infected birds. *International Journal for Parasitology* 50, 569-575. DOI: 10.1016/j.ijpara.2020.03.013	Health	Huelva	Experimental lab	Captivity	WoS
80	Ferraguti M, Heesterbeek H, Martínez-de la Puente J, Jiménez-Clavero MÁ, Vázquez A, Ruiz S, Llorente F, Roiz D, Vernooij H, Soriguer R, Figuerola J, 2021a. The role of different *Culex* mosquito species in the transmission of West Nile virus and avian malaria parasites in Mediterranean areas. *Transboundary and Emerging Diseases* 68, 920-930. DOI: 10.1111/tbed.13760	Health	Huelva; Seville; Cádiz	Observational lab	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
81	Ferraguti M, Martínez-de la Puente J, Bensch S, Roiz D, Ruiz S, Viana DS, Soriguer RC, Figuerola J, 2018. Ecological determinants of avian malaria infections: An integrative analysis at landscape, mosquito and vertebrate community levels. *Journal of Animal Ecology* 87, 727-740. DOI: 10.1111/1365-2656.12805	Health	Huelva; Seville; Cádiz	Observational lab	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
82	Ferraguti M, Martínez-de la Puente J, García-Longoria L, Soriguer R, Figuerola J, Marzal A, 2019. From Africa to Europe: evidence of transmission of a tropical *Plasmodium* lineage in Spanish populations of house sparrows. *Parasites and Vectors* 12, 548. DOI: 10.1186/s13071-019-3804-1	Health	Badajoz	Observational lab	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
83	Ferraguti M, Martínez-de la Puente J, Jiménez-Clavero MÁ, Llorente F, Roiz D, Ruiz S, Soriguer R, Figuerola J, 2021b. A field test of the dilution effect hypothesis in four avian multi-host pathogens. *Plos Pathogens* 17, e1009637. DOI: 10.1371/journal.ppat.1009637	Health	Huelva; Seville; Cádiz	Observational lab; Experimental field	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
84	Garcia-Longoria L, Magallanes S, Huang X, Drews A, Råberg L, Marzal A, Bensch S, Westerdahl H, 2022. Reciprocal positive effects on parasitemia between coinfecting haemosporidian parasites in house sparrows. *BMC Ecology and Evolution* 22, 73. DOI: 10.1186/s12862-022-02026-5	Health	Badajoz	Observational lab	Urban (City)	WoS
85	Garcia-Longoria L, Møller AP, Balbontín J, De Lope F, Marzal A, 2015. Do malaria parasites manipulate the escape behaviour of their avian hosts? An experimental study. *Parasitology Research* 114, 4493-4501. DOI: 10.1007/s00436-015-4693-7	Health	Badajoz	Experimental lab	Urban (City)	WoS
86	Gonzalez G, Sorci G, De Lope F, 1999a. Seasonal variation in the relationship between cellular immune response and badge size in male house sparrows (*Passer domesticus*). *Behavioral Ecology and Sociobiology* 46, 117-122. DOI: 10.1007/s002650050600	Health	Badajoz	Experimental lab	Agricultural	WoS
87	Gonzalez G, Sorci G, Møller AP, Ninni P, Haussy C, De Lope F, 1999b. Immunocompetence and condition-dependent sexual advertisement in male house sparrows (*Passer domesticus*). *Journal of Animal Ecology* 68, 1225-1234. DOI: 10.1046/j.1365-2656.1999.00364.x	Health	Badajoz	Experimental lab	Captivity	WoS
88	Gutiérrez-López R, Martínez-de la Puente J, Gangoso L, Soriguer R, Figuerola J, 2019a. Effects of host sex, body mass and infection by avian *Plasmodium* on the biting rate of two mosquito species with different feeding preferences. *Parasites and Vectors* 12, 87. DOI: 10.1186/s13071-019-3342-x	Health	Huelva	Experimental lab	Captivity	WoS
89	Gutiérrez-López R, Martínez-de la Puente J, Gangoso L, Yan J, Soriguer R, Figuerola J, 2019b. Experimental reduction of host *Plasmodium* infection load affects mosquito survival. *Scientific Reports* 9, 8782. DOI: 10.1038/s41598-019-45143-w	Health	Huelva	Experimental lab	Urban (Town)	WoS

Table S2. (Cont.)

	Reference	Topic	Study location	Study type	Habitat	Database
90	Herrera-Dueñas A, Pineda J, Antonio MT, Aguirre JI, 2014. Oxidative stress of house sparrow as bioindicator of urban pollution. *Ecological Indicators* 42, 6-9. DOI: 10.1016/j.ecolind.2013.08.014	Health	Madrid	Observational lab	Urban (City); Urban (Town)	WoS
91	Herrera-Dueñas A, Pineda-Pampliega J, Antonio-García MT, Aguirre JI, 2017. The Influence of Urban Environments on Oxidative Stress Balance: A Case Study on the house sparrow in the Iberian Peninsula. *Frontiers in Ecology and Evolution* 5, 106. DOI: 10.3389/fevo.2017.00106	Health	Madrid; Cáceres	Observational lab	Urban (City); Urban (Town)	WoS
92	Jiménez-Peñuela J, Ferraguti M, Martínez-de la Puente J, Soriguer RC, Figuerola J, 2023. Oxidative status in relation to blood parasite infections in house sparrows living along an urbanization gradient. *Environmental Pollution* 316, 120712. DOI: 10.1016/j.envpol.2022.120712	Health	Huelva; Seville; Cádiz	Observational lab	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
93	Jiménez-Peñuela J, Ferraguti M, Martínez-de la Puente J, Soriguer RC, Figuerola J, 2021. Urbanization effects on temporal variations of avian haemosporidian infections. *Environmental Research* 199, 111234. DOI: 10.1016/j.envres.2021.111234	Health	Huelva	Observational lab	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
94	Llorente F, Pérez-Ramírez E, Fernández-Pinero J, Elizalde M, Figuerola J, Soriguer RC, Jiménez-Clavero MÁ, 2015. Bagaza virus is pathogenic and transmitted by direct contact in experimentally infected partridges, but is not infectious in house sparrows and adult mice. *Veterinary Research* 46, 93. DOI: 10.1186/s13567-015-0233-9	Health	Seville	Experimental lab	Captivity	WoS
95	López G, Jiménez-Clavero MÁ, Tejedor CG, Soriguer R, Figuerola J, 2008. Prevalence of West Nile Virus neutralizing antibodies in Spain is related to the behavior of migratory birds. *Vector-Borne and Zoonotic Diseases* 8, 615-622. DOI: 10.1089/vbz.2007.0200	Health	Seville	Observational lab	Agricultural	WoS
96	Magallanes S, García-Longoria L, Muriel J, De Lope F, Marzal A, 2020. Variation of uropygial gland volume and malaria infection between urban-rural environment in the house sparrow. *Ecosistemas* 29, 1977. DOI: 10.7818/ECOS.1977	Health	Badajoz	Observational lab	Urban (City); Natural environments	WoS
97	Magallanes S, Møller AP, García-Longoria L, De Lope F, Marzal A, 2016. Volume and antimicrobial activity of secretions of the uropygial gland are correlated with malaria infection in house sparrows. *Parasites and Vectors* 9, 232. DOI: 10.1186/s13071-016-1512-7	Health	Badajoz	Observational lab	Urban (City); Natural environments	GS
98	Martínez-de la Puente J, Ferraguti M, Ruiz S, Roiz D, Llorente F, Pérez-Ramírez E, Jiménez-Clavero MÁ, Soriguer R, Figuerola J, 2018. Mosquito community influences West Nile virus seroprevalence in wild birds: implications for the risk of spillover into human populations. *Scientific Reports* 8, 2599. DOI: 10.1038/s41598-018-20825-z	Health	Cadiz; Huelva; Seville	Observational lab	Urban (City); Urban (Town); Agricultural; Natural environments	WoS
99	Martínez-Haro M, Viñuela J, Mateo R, 2007. Exposure of birds to cholinesterase-inhibiting pesticides following a forest application for tick control. *Environmental Toxicology and Pharmacology* 23, 347-349. DOI: 10.1016/j.etap.2006.11.011	Health	Cádiz	Experimental field	Natural environments	WoS
100	Marzal A, Møller AP, Espinoza K, Morales S, Luján-Vega C, Cárdenas-Callirgos JM, Mendo L, Álvarez-Barrientos A, González-Blázquez M, García-Longoria L, De Lope F, Mendoza C, Iannacone J, Magallanes S, 2018. Variation in malaria infection and immune defence in invasive and endemic house sparrows. *Animal Conservation* 21, 505-514. DOI: 10.1111/acv.12423	Health	Badajoz	Observational lab	Urban (City)	WoS
101	Moreno-Rueda G 2010a. An immunological cost of begging in house sparrow nestlings. *Proceedings of the Royal Society B: Biological Sciences* 277, 2083-2088. DOI: 10.1098/rspb.2010.0109	Health	Granada	Experimental lab	Captivity	GS
102	Moreno-Rueda G, 2010b. Experimental test of a trade-off between moult and immune response in house sparrows *Passer domesticus*. *Journal of Evolutionary Biology* 23, 2229-2237. DOI: 10.1111/j.1420-9101.2010.02090.x	Health	Granada	Experimental lab	Agricultural	GS
103	Moreno-Rueda G, 2005. Is the white wing-stripe of male house sparrows *Passer domesticus* an indicator of the load of Mallophaga? *Ardea* 93, 109-114.	Health	Granada	Observational lab	Captivity	WoS
104	Moreno-Rueda G, 2011b. Trade-off between immune response and body mass in wintering house sparrows (*Passer domesticus*). *Ecological Research* 26, 943-947. DOI: 10.1007/s11284-011-0848-x	Health	Granada	Experimental lab	Captivity	WoS
105	Navarro C, De Lope, Møller, AP, 2007. Digit ratios (2D:4D), secondary sexual characters and cell-mediated immunity in house sparrows *Passer domesticus*. *Behavioral Ecology and Sociobiology* 61, 1161-1168. DOI: 10.1007/s00265-006-0329-3	Health	Badajoz	Experimental lab	Agricultural	GS

Table S2. (Cont.)

	Reference	Topic	Study location	Study type	Habitat	Database
106	Neto JM, Mellinger S, Halupka L, Marzal A, Zehtindjiev P, Westerdahl H, 2020. Seasonal dynamics of haemosporidian (Apicomplexa, Haemosporida) parasites in house sparrows *Passer domesticus* at four European sites: comparison between lineages and the importance of screening methods. *International Journal for Parasitology* 50, 523-532. DOI: 10.1016/j.ijpara.2020.03.008	Health	Badajoz	Observational lab	Agricultural	WoS
107	Puerta M, Nava MP, Venero C, Veiga JP, 1995. Hematology and plasma chemistry of house sparrows (*Passer domesticus*) along the summer months and after testosterone treatment. *Comparative Biochemistry and Physiology Part A: Physiology* 110, 303-307. DOI: 10.1016/0300-9629(94)00187-X	Health	Madrid	Experimental lab	NA	WoS
108	Ruiz-Martínez J, Ferraguti M, Figuerola J, Martínez-de la Puente J, Williams RAJ, Herrera-Dueñas A, Aguirre JI, Soriguer R, Escudero C, Moens MAJ, Pérez-Tris J, Benítez L, 2016. Prevalence and genetic diversity of Avipoxvirus in house sparrows in Spain. *Plos One* 11, e0168690. DOI: 10.1371/journal.pone.0168690	Health	Madrid; Cáceres; Huelva	Observational lab; Experimental field	Urban (Town); Agricultural; Natural environments	WoS
109	Sacristán C, Esperón F, Herrera-León S, Iglesias I, Neves E, Nogal V, Muñoz MJ, De La Torre A, 2014. Virulence genes, antibiotic resistance and integrons in *Escherichia coli* strains isolated from synanthropic birds from Spain. *Avian Pathology* 43, 172-175. DOI: 10.1080/03079457.2014.897683	Health	Madrid	Observational lab	NA	WoS
110	Veiga JP, Puerta M, 1996. Nutritional constraints determine the expression of a sexual trait in the house sparrow, *Passer domesticus*. *Proceedings of the Royal Society of London Series B: Biological Sciences* 263, 229-234. DOI: 10.1098/rspb.1996.0036	Health	Madrid	Observational lab; Experimental field	Natural environments	GS
111	Ventim R, Mendes L, Ramos JA, Cardoso H, Pérez-Tris J, 2012a. Local haemoparasites in introduced wetland passerines. *Journal of Ornithology* 153, 1253-1259. DOI: 10.1007/s10336-012-0860	Health	Coimbra; Leiria; Setúbal; Faro (Portugal)	Observational lab	Natural environments	WoS
112	Ventim R, Morais J, Pardal S, Mendes L, Ramos JA, Pérez-Tris J, 2012b. Host-parasite associations and host-specificity in haemoparasites of reed bed passerines. *Parasitology* 139, 310-316. DOI: 10.1017/S0031182011002083	Health	Coimbra; Leiria; Setúbal; Faro (Portugal)	Observational lab	Natural environments	WoS
113	Ventim R, Tenreiro P, Grade N, Encarnação P, Araújo M, Mendes L, Pérez-Tris J, Ramos JA, 2012c. Characterization of haemosporidian infections in warblers and sparrows at south-western European reed beds. *Journal of Ornithology* 153, 505-512. DOI: 10.1007/s10336-011-0767-1	Health	Coimbra; Setúbal; Faro (Portugal)	Observational lab	Natural environments	WoS
114	Yan J, Martínez-de la Puente J, Gangoso L, Gutiérrez-López R, Soriguer R, Figuerola J, 2018. Avian malaria infection intensity influences mosquito feeding patterns. *International Journal for Parasitology* 48, 257-264. DOI: 10.1016/j.ijpara.2017.09.005	Health	Huelva	Experimental lab	Captivity	WoS