



Focus

Ornithology in Spain: a descriptive overview based on doctoral theses read in recent decades

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This work summarizes variation over time in the 317 doctoral theses on ornithology defended in Spain between 2000 and 2019 whose abstracts have been published in the section *Reviews of doctoral theses in Ornithology* in the scientific journal *Ardeola*. These were analyzed in terms of (i) the relative contribution by each university, (ii) the research topics tackled, (iii) the taxonomic groups studied and (iv) differences in author gender. The number of theses defended annually is around 15, but there is an upward trend. Complutense and Barcelona universities hosted the highest number of theses, followed by the Autonomous University of Madrid and the University of Granada. The most selected topics were conservation and reproduction biology, followed by habitat selection, population dynamics and physiology, while the most studied groups of birds were Passeriformes (and within this order, the Paridae), followed by Charadriiformes and diurnal raptors. The number of PhD theses defended by males is higher than those read by females; both genders, however, show a similar positive upward trend in the number of theses read. Our results are an indication of how trends and subject-matters in ornithological research in Spain have progressed in recent years.

Key words: bibliometric analysis, birds, early-career researcher, gender-gap, research topic, PhD dissertation.

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Ornithological science has a long and, in recent years, growing tradition in Spain (Barbosa & Moreno 2004). It is now possible to study the changes over time in ornithology using bibliometric methods that analyze information and the evolution of different aspects of scientific literature (Powell *et al.* 2010). Bibliometric analyses offer a fresh approach to the current state of knowledge that differ from that provided by traditional literature reviews (Grant & Booth 2009). This is hugely important in older scientific disciplines such as ornithology that have longer traditions and in which there is greater

interest. Despite this, few scientific literature reviews have ever been carried out of Spanish ornithology (Carrascal & Díaz 1998, Barbosa & Moreno 2004, Gordo 2014, Díaz *et al.* 2016, Morales & Traba 2016) and, of these, only one has focused on ornithological PhD dissertations, specifically in the period 1990–1999 (Barbosa 2000a). Although the goals and the research topics addressed in PhD theses provide a good overview of the progress of ornithological research, no other review of PhD dissertations has been published in Spain since 2000 (Barbosa 2000a). Moreover, the reviews of PhD disserta-

tions allow for research topics and species to be more carefully chosen and the efforts of future lines of research to be better focused, especially in the case of early-career researchers (Bautista & Pantoja 2000).

The aim of this study was to summarize the variation over time, the relative contribution of each university, the research topics addressed, the groups of species studied, and author gender in PhD theses published in Spain in 2000–2019. The results are contrasted with those obtained by Barbosa (2000a), the only previous PhD dissertation review published in Spain.

Materials and methods

For the bibliometric analysis we gathered information on theses defended in 2000–2019 whose abstracts have been published in the section *Review of Doctoral Theses in Ornithology* in *Ardeola: International Journal of Ornithology* in recent years (Barbosa 2000b, 2001, 2003, Valera 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2017, 2018, 2019, 2020, 2021). We analysed the same variables as used by Barbosa (2000a), namely, (i) the number of theses defended per year [given that the reviews of doctoral theses in *Ardeola* are referred to by academic course (e.g. 1994/1995; 2009/2010, etc.), a search for the exact year a thesis was defended was carried out in different databases:

Teseo[®] v.4.2, Dialnet[®] and universities' repositories], (ii) the number of theses defended at each university, (iii) the assignment of research topics in each previously used by Barbosa (2000a) and defined by Bautista & Pantoja (2000), and (iv) the taxonomic classification (Order) of the species studied in each thesis (and, if within the order Passeriformes, which family), and whether or not it corresponds to an indigenous or non-native bird group for Spain (Iberian Peninsula and Canary and Balearic Islands). Finally, (v) we also analyzed differences in gender in dissertation authorship over the years. All dissertations were revised by the same person (JM-B) to avoid biases in categorical classifications.

The Shapiro-Wilk test was used to assess the Normality of the temporal range (study period < 50 years). We used descriptive statistics and a Pearson correlation (as a parametric analysis) to evaluate trends over time of the variables mentioned, correlating each of them to the range-years. We applied a simple linear regression, Chi-square and an analysis of covariance tests to evaluate trends and differences in the author gender-gap. In addition, we carried out a Kendall rank correlation coefficient to identify differences between research topic categories, bird orders and the Passeriforme families studied in the 90s (Barbosa, 2000a) and in our study period as a percentage of each variable in relation to the total for both periods. We used Cramer's V correlation to explore potential associations

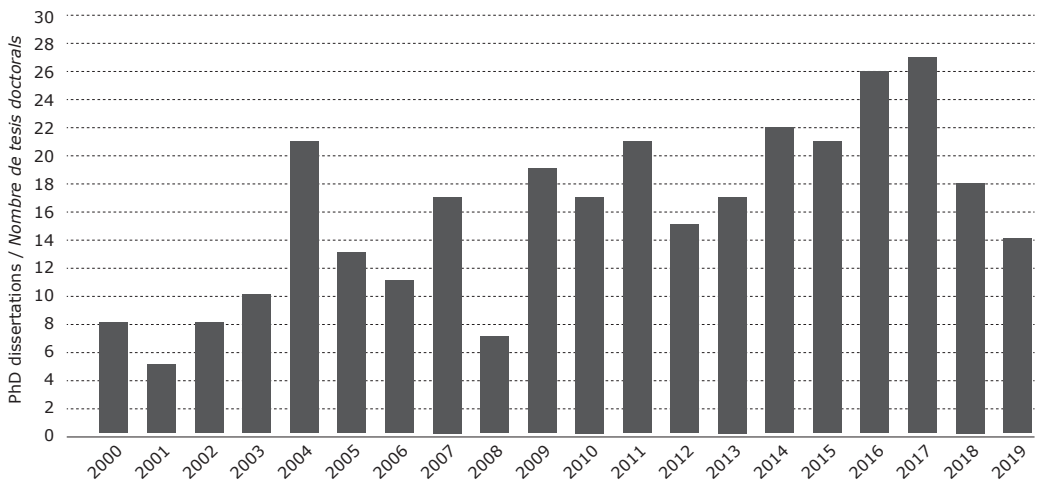


Figure 1. Number of PhD dissertations in ornithology defended in Spain with abstracts published in *Ardeola* in 2000–2019.

Nombre de tesis doctorals en ornitologia a Espanya recollides a Ardeola entre 2000 i 2019.

between pairs of research topics included together in the same thesis. All analyses were performed using the R program version 4.1.1 (R Development Core Team, 2021) with the visual editor R Studio version 2021.09.0+351 (RStudio Team, 2021). The statistical results are given as a mean \pm SD and the significant level was set at $P < 0.05$.

Given that the same study may cover more than one bird taxonomic classification or research topic, the sum of the values of these variables is greater than the number of total PhD dissertations considered in the bibliometric analysis.

Results

A total of 317 ornithological PhD dissertations were defended and had abstracts published in *Ardeola* in 2000–2019 in Spain, an average of 15.85 ± 6.29 per year, with a maximum of 27 in 2017 and a minimum of 5 in 2001 (Fig. 1). There was a growing trend in the number of theses during the study period (Pearson correlation: $r = 0.693$, $N = 20$, $P < 0.001$). These PhD dis-

sertations were defended at a total of 34 Spanish universities (Fig. 2), the Complutense University of Madrid being the one with the largest number of theses (40 theses representing 12.62% of the total), followed by the University of Barcelona (34, 10.72%), the Autonomous University of Madrid (28, 8.83%) and the University of Granada (23, 7.25%).

The most commonly tackled subjects were Conservation (67, 13.03%) and Reproduction (66, 12.84%), followed by Habitat selection (63, 12.25%), Feeding (56, 10.89%) and Population dynamics (52, 10.12%). By contrast, the least treated topics were Biogeography (4, 0.78%), Paleontology (2, 0.38%) and Systematics (1, 0.19%) (Fig. 3). There was no significant association between pairs of research topics studied together (Cramers's V coefficient: $\phi_c < 0.3$, $P > 0.05$) (Fig. 4).

A total of 25 bird orders were explored in these PhD dissertations. The Passeriformes order was the most studied group (37.54% of all theses) (Fig. 5). Within this order, a total of 30 families were studied, the Paridae being the family with the most theses (18.33%), followed by the Corvidae, Muscicapidae and Turdidae,

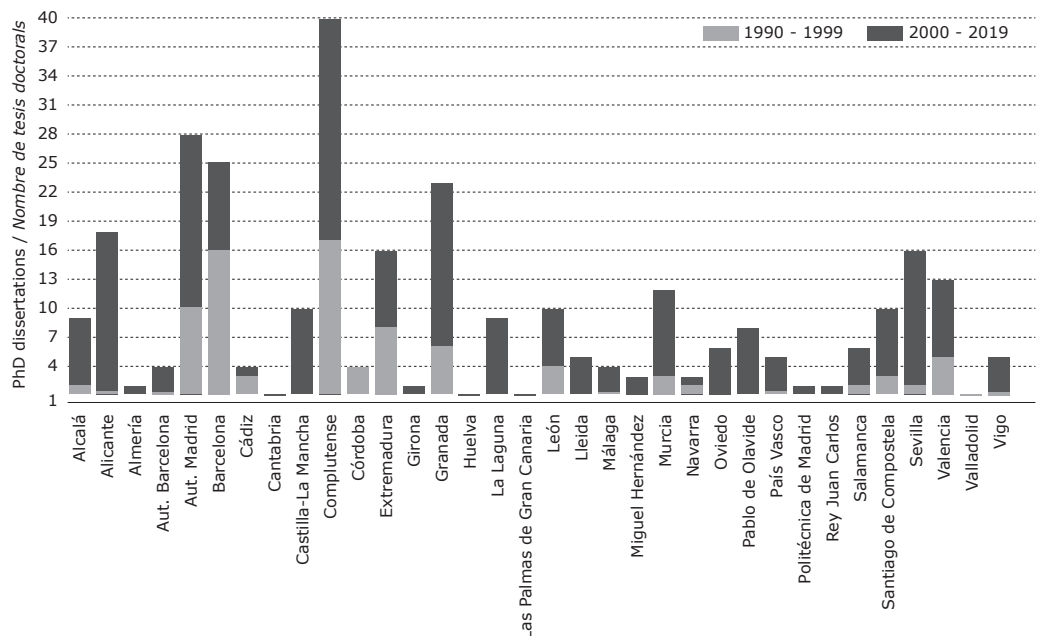


Figure 2. Number of PhD dissertations defended in Spain with abstracts published in *Ardeola* in 1990–1999 (for more details, see Barbosa 2000a) and 2000–2019 (this study) by university. *Nombre de tesis doctorals publicades a Ardeola a Espanya entre 1990–1999 (vegeu més detalls a Barbosa 2000a) i 2000–2019 (aquest estudi) per universitat.*

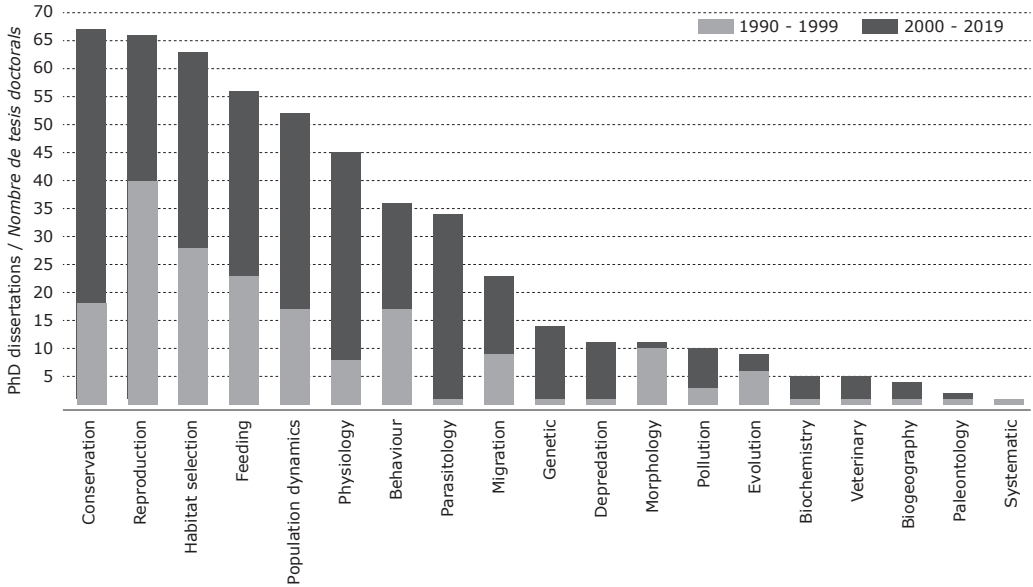


Figure 3. Number of PhD dissertations defended in Spain with abstracts published in *Ardeola* in 1990–1999 (for more details, see Barbosa 2000a) and 2000–2019 by research topic. *Nombre de tesis doctorals a Espanya entre 1990–1999 (vegeu més detalls a Barbosa 2000a) i 2000–2019 recollides a Ardeola per tema de recerca.*

each representing 8.33% of this order (Fig. 6). In all, 34 PhD theses studied bird communities without focussing on particular species, families or orders.

There was a significant difference ($\chi^2 = 14.161$, $df = 1$, $P < 0.001$) in the number of theses defended by women (125) and men (197). In both genders there was a positive growth in the number of theses defended over the years – women ($r = 0.728$, $N = 20$, $P < 0.001$) and men ($r = 0.434$, $N = 20$, $P = 0.056$) – but there was no significant difference (ANCOVA: $F_{1,1} = 1.468$, $P = 0.233$) in the growth trend between the two genders (Fig. 7).

The total number of PhD dissertations represents an increase of 240.86% over the total registered by the end of the 1990s (93 theses; Barbosa 2000a); there was a significant difference in the number of theses defended annually between these two periods [1990–1999, 9.30 ± 4.31 (Barbosa 2000a); 2000–2019, 15.85 ± 6.29 ; ANOVA: $F_{1,29} = 8.319$, $P = 0.007$].

The number of universities hosting PhD dissertations increased by 61.90%, with 13 new universities appearing between 2000 and 2019: Almería, Cantabria, Castilla-La Mancha, Girona, Huelva, La Laguna, Las Palmas de Gran

Canaria, Lleida, Miguel Hernández, Oviedo, Pablo de Olavide, Madrid Polytechnic and the University Rey Juan Carlos (Fig. 2).

Reproduction and Habitat selection remained in the top three research topics, and was joined by *Conservation*, which underwent an increase of 346.67% during the study period, the largest increase relative to the number of theses defended in the 1990s (only 15 theses in the 90s, representing 16.13% studied *Conservation*) (Fig. 4). Significant differences compared to the 90s were found regarding the percentage of each research topic category (Kendall’s coefficient: $\tau = 0.739$; $P < 0.001$). In total 12 new bird orders were tackled (an increase of 92.31%), nine of which are native to the Iberian Peninsula (Apodiformes, Bucerotiformes, Columbiformes, Otidiformes, Podicipediformes, Phoenicopteriformes, Piciformes, Suliformes and Strigiformes) and three non-native (Psittaciformes, Sphenisciformes and Trochiliformes) (Fig. 4). Within the Passeriformes, the number of families studied increased by 150%, with a total of 18 new families studied, of which 10 are native to Spain (Acrocephalidae, Aegithalidae, Certhiidae, Cinclidae, Emberizidae, Furnariidae, Laniidae, Motacillidae, Phylloscopidae and Troglodyti-

dae) and 8 non-native (Cardinalidae, Icteridae, Leiostichidae, Parulidae, Passerellidae, Rhinocryptidae, Tyrannidae and Vireonidae) (Fig. 5). The Rheiformes order was the only family that was not maintained as a thesis study group between the two periods. These changes reveal significant differences in the taxonomic groups studied between the two periods (Bird order: $\tau = 0.440$; $P = 0.004$; Passeriforme families: $\tau = 0.597$; $P < 0.001$).

Discussion

Between 2000 and 2019 the number of PhD theses defended in Spain with abstracts published in *Ardeola* grew to 317. This trend in the number of PhD dissertations indicates that the research effort and interest detected at the beginning of the 2000s in ornithology in Spain has continued and even increased (Barbosa 2000a, Barbosa & Moreno 2004). The increase in the number of universities and number of theses defended there, together with the sizeable increase in the array of orders and families of birds studied, reveal a general growth in ornithological research. However, this growth is not uniform and there are still great differences in the number of theses defended in universities. These differences can be explained by the size, seniority (universities such as the Universities of Huelva and Almeria were only founded in 1993, Miguel Hernández in 1996, Pablo de Olavide in 1996 and Rey Juan Carlos in 1997), the type of research lines (Barbosa 2000a), and the number of pre-doctoral researchers or PhD students from non-university research centers that receive doctoral programs from each university.

Compared to the 1990s (Barbosa 2000a), during the study period conservation studies became the most studied topic in ornithological PhD dissertations. This reflects concern in the scientific community regarding the general state of conservation of birds and their habitats in Spain in recent years, which has become one of main research topics in Spanish ornithology (Díaz *et al.* 2016). In addition, it is worth highlighting the great growth in topics such as physiology, parasitology and genetics, probably associated with the greater accessibility and use of new technologies in recent decades that has led to marked differences compared to the 1990s.

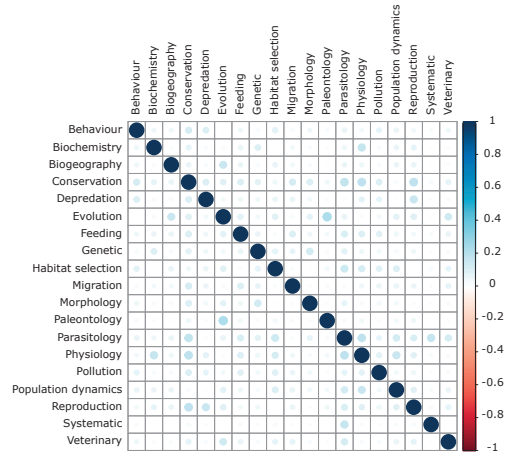


Figure 4. Correlation matrix based on Cramer's V coefficient as a measure of association between pairs of research topics studied in these theses with abstracts published in *Ardeola* in 2000–2019 ($\varphi_c < 0.3$, $P > 0.05$ for all pairs of associations).

Matriu de correlació basada en el coeficient V de Cramer com a mesura d'associació entre parells de temes d'investigació abordats en conjunt en les mateixes tesis publicades a Ardeola entre 2000–2019 ($\varphi_c < 0.3$, $P > 0.05$ per a tots els parells d'associacions).

Although there were some differences between the two periods regarding the most studied bird taxonomic groups, the Passeriformes, Charadriiformes and the two orders of diurnal raptors (Accipitriformes and Falconiformes) continue to be the most studied taxonomic groups. In addition, the Paridae remain the most studied Passeriforme family. Wide-ranging differences continue to exist between the research efforts devoted to certain groups of birds, possibly due to factors such as the number of species that each order group contains (Barbosa 2000a), the interest of researchers in certain species (i.e., emblematic species, species in decline or species with long-term ongoing studies), and/or the characteristics of species including their breeding systems, population size and their ease of observation, capture and management. These factors all affect field sampling and data recording in the short term, and can facilitate the work of researchers and increase productivity and the frequency of publication (Thomas *et al.* 2003, Barbosa & Moreno 2004).

However, we also found a large increase in the number of both native and non-native taxonomic groups studied in PhD theses defended in Spain. This may mean that the main lines

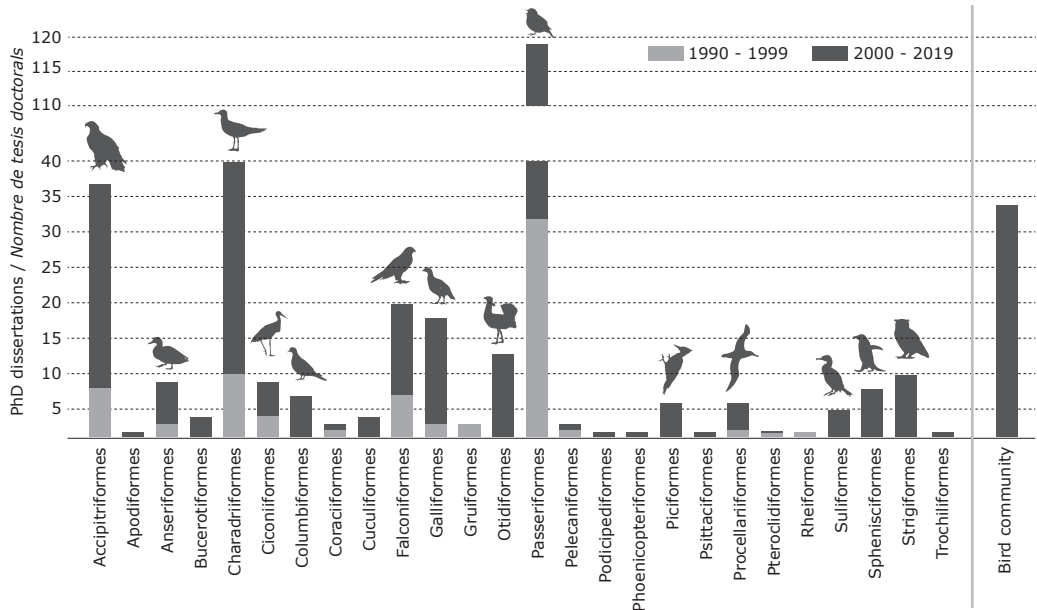


Figure 5. Number of PhD dissertations defended in Spain with abstracts published in *Ardeola* (for more details, see Barbosa 2000a) in 1990–1999 and 2000–2019 by bird order or focused on bird communities. *Nombre de tesis doctorals a Espanya entre 1990–1999 (vegeu més detalls a Barbosa 2000a) i 2000–2019 recollides a Ardeola per ordre d'ocells i centrades en comunitats d'ocells com a objecte d'estudi.*

of research addressed over the years in Spain, including long-term studies in species already studied, are being maintained, and, in addition, that new bird groups and new research lines are being explored. Research into new taxonomic groups not present in Spain can be explained by the increase in international cooperation in research (Díaz *et al.* 2016), the growing interest in certain groups of birds at international level, e.g. Sphenisciformes (Menéndez-Blázquez 2020), and the need for researchers to find outside Spain new areas and/or species that have not been the subject of prior research. It should be noted that during the study period a large number of PhD dissertations focused on bird communities without specifying species. This increase in the use of bird communities as an object of study could be linked to the increase in PhD dissertations focused on conservation. In total, 52.94% (18) of PhD dissertations that used bird communities as a study subject focused on conservation, which can be explained by the widespread use of these communities as indicators of changes in and the conservation of ecosystems in recent years (Canterbury *et al.* 2000, Padoa-Schioppa *et al.* 2006, Banks-Leite *et al.* 2011, Mekonen 2017).

The differences found in the number of doctoral theses defended by men and women reflects the gender inequality present in the early stages of researchers' careers in ornithology (Jähnig *et al.* 2019), which may be reflected in subsequent scientific production, as is the case in zoology and ecology (Yarwood *et al.* 2014, Salerno *et al.* 2019). Despite these differences, there is a marked upward trend in the number of women completing doctoral theses, similar to the trend for women to be named as lead authors in ornithological publications (Yarwood *et al.* 2014, Salerno *et al.* 2019). This highlights the importance of continuing to undertake this kind of review in Spain and in other countries. These reviews clarify the causes of widespread gender differences (Lerman *et al.* 2021), which will help minimize this gender gap in the future and make ornithology – and all other scientific disciplines – an egalitarian science in terms of authorship and scientific output at different stages in researchers' careers.

The search method used in this study may have certain biases that need to be taken into account when interpreting the results (especially regarding data with few records such as universities or bird taxonomic groups). We took into ac-

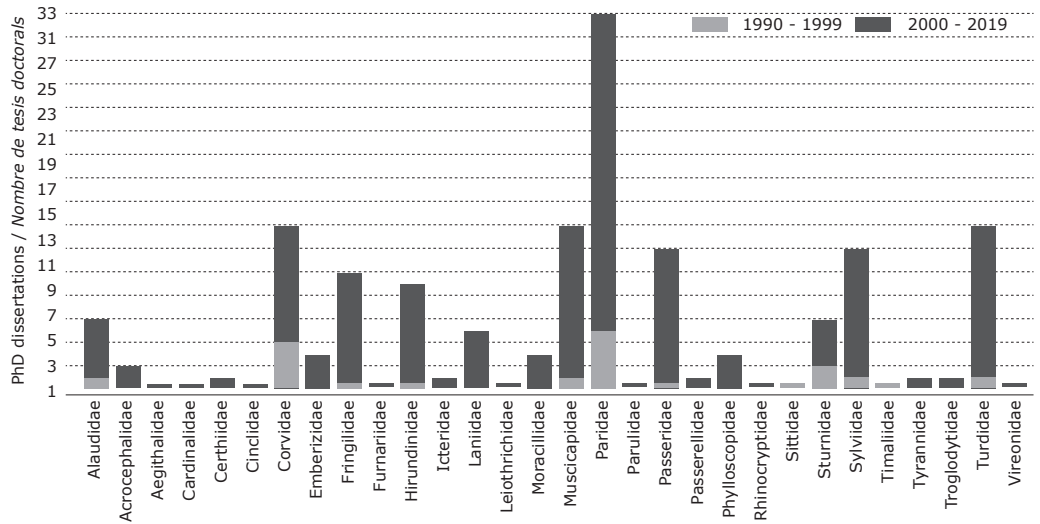


Figure 6. Number of PhD dissertations defended in Spain with abstracts published in *Ardeola* in 1990–1999 (for more details, see Barbosa 2000a) and 2000–2019 by families belonging to the order Passeriformes. *Nombre de tesis doctorals a Espanya entre 1990–1999 (vegeu més detalls a Barbosa 2000a) i 2000–2019 recollides a Ardeola per família dins l'ordre dels Passeriformes.*

count all PhD dissertations whose abstracts have been published in the section *Review of Doctoral Theses in Ornithology* in *Ardeola: International Journal of Ornithology*, which a priori represents a sample of the total number of theses defended in Spain. This may be caused by possible biases arising from the process and effort of screening the PhD theses published in the section by its editors: A public request is made and together a more personally invitation to a PhD candidates and directors to report on the theses they have recently read or supervised, and to they can spread the word about the section in *Ardeola* for new potential theses review. The effort to highlight the doctoral theses that are read differs from one year to another and its success may be biased by the editor's contacts (Valera, pers. comm.). In addition, the acceptance of the way reviews are submitted to the section by PhD thesis supervisors as part of their outreach policy and work should be taken into account given the lack of awareness of this section in *Ardeola*, both by junior and senior researchers. Nonetheless, the search by editor for abstracts of theses in the aforementioned section in *Ardeola* also involved a search of Teseo[®] – a database of all PhD dissertations defended in Spain (Barbosa, 2000a; Varela, pers. comm.) – and so the sample gathered in this section of the journal

can be taken as a reliable representation of the total number of doctoral theses in ornithology defended in Spain.

In this review we have attempted to show the current state of and the changes occurring in ornithological PhD dissertations read in 2000–2019 in Spain. The use of this type of bibliometric analysis of scientific publications derived from PhD dissertations allows for a detailed vision of these trends and their contribution to ornithological knowledge. This study transcends the mere historical vision of PhD dissertations and provides an overview of the trends and the general interests pursued by ornithologists, as well as sociological factors involved (e.g., the gender-gap).

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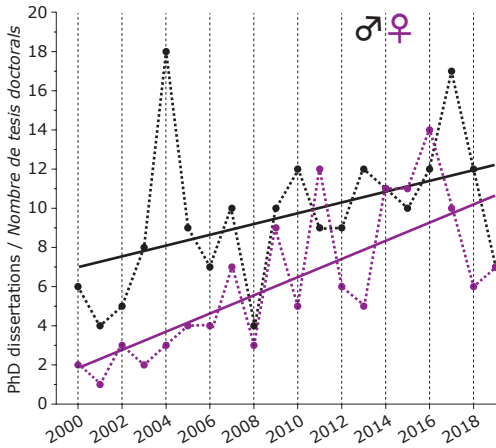


Figure 7. Number of PhD dissertations defended in Spain with abstracts published in *Ardeola* in 2000–2019 by author gender. The dashed black and grey lines represent, respectively, the annual number of male and female PhD authors. The solid black and purple lines show the linear regression fit of the number of theses by men ($Y = -540.40 + 0.274 \cdot \text{year}$; $R^2 = 0.19$; $P = 0.561$) and women ($Y = -926.00 + 0.464 \cdot \text{year}$; $R^2 = 0.53$; $P < 0.001$), respectively.

Nombre de tesis doctorals a Espanya entre 2000 i 2019 recollides a Ardeola per gènere de l'autor. Les línies discontinues en negre i gris representen el nombre d'homes i dones autors de doctorat per any, respectivament. La línia negra i lila mostra l'ajust de regressió lineal del nombre d'articles d'homes ($Y = -540.40 + 0,274 \cdot \text{any}$; $R^2 = 0.19$; $P = 0.561$) i de dones ($Y = -926.00 + 0.464 \cdot \text{any}$; $R^2 = 0.53$; $P < 0.001$) respectivament.

Doctoral Theses in Ornithology in *Ardeola* (as well as to its editor) that enabled this work to be undertaken. This study was conducted with no public or private funding.

Resum

L'ornitologia a Espanya: una imatge descriptiva a través de les tesis doctorals llegides en les darreres dècades

Aquest treball resumeix la variació temporal de les 317 tesis doctorals sobre ornitologia defensades a Espanya i publicades en la secció *Resenyes de tesis doctorals en Ornitologia a Ardeola* entre els anys 2000 i 2019, així com la contribució relativa de cada universitat, els temes d'investigació abordats, els grups d'espècies estudiades i les diferències en el gènere dels autors. El nombre de tesis defensades a l'any oscil·la entorn de 15 amb una tendència a l'alça. La Universitat Complutense i la Universitat de Barcelona van ser les que van albergar el major nombre de tesis, seguides per l'Autònoma de Madrid i la Universitat de Granada. La temàtica més abordada va ser la conservació i la biologia de la repro-

ducció, seguit per la selecció d'hàbitat, la dinàmica de poblacions i la fisiologia. El grup d'ocells més estudiat van ser els Passeriformes (i dins d'ells els pàrids), seguit dels Caradriformes i les rapinyaires diürnes. El nombre de tesis doctorals defensades per homes és més gran respecte a les dones, presentant ambdós gèneres una tendència positiva similar en la producció de tesis. Els resultats obtinguts representen una aproximació del desenvolupament, tendències i interessos de la investigació ornitològica a Espanya en els últims anys.

Resumen

La ornitología en España: una imagen descriptiva a través de las tesis doctorales leídas en las últimas décadas

Este trabajo resume la variación temporal de las 317 tesis doctorales sobre ornitología defendidas en España entre los años 2000 y 2019 y recogidas en la sección *Reseñas de tesis doctorales en Ornitología en Ardeola*, así como la contribución relativa de cada universidad, los temas de investigación abordados, los grupos de especies estudiadas y las diferencias en el género de los autores de las mismas. El número de tesis defendidas al año oscila en torno a 15 con una tendencia al alza. La Universidad Complutense y la Universidad de Barcelona fueron las que se leyó un mayor número de tesis, seguidas por la Autónoma de Madrid y la Universidad de Granada. Las temáticas más abordadas fueron conservación y biología de la reproducción, seguidas por la selección de hábitat, la dinámica de poblaciones y la fisiología. El grupo de aves más estudiado fueron los Paseriformes (y dentro de ellos los pàrids), seguido de los Charadriformes y las rapaces diurnas. El número de tesis doctorales defendidas por hombres es mayor respecto a las mujeres, presentando ambos géneros una tendencia positiva similar en la producción de tesis. Los resultados obtenidos representan una aproximación del desarrollo, tendencias e intereses de la investigación ornitológica en España en los últimos años.

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Supplementary material

The complete list of PhD dissertations from 1990–2019 whose abstracts have been published in *Ardeola* can be found at <https://doi.org/10.6084/m9.figshare.16944913.v1>

