

PHD-DISSERTATION REVIEWS IN ORNITHOLOGY (2020-2021 academic year)

Edited by Francisco VALERA

This section includes the abstracts of some of the PhD-Dissertations submitted in Spain during the 2020-2021 academic year as well as some others not published in earlier volumes of *Ardeola*. They are in alphabetical order by University where they were presented and, then, by year and alphabetical order of the author's surname. This section also includes a link to access the full version of the reviewed thesis when available.

Esta sección incluye los resúmenes de algunas de las Tesis Doctorales en Ornitología defendidas en España en el curso 2020-2021 junto con otras no recogidas en reseñas anteriores. Se ha seguido una ordenación alfabética por universidades y, dentro de ellas, por año y autor. También se incluye un vínculo que permite acceder a la versión completa de la tesis reseñada en caso de que esté disponible.

Informative note:

In its section PhD-Dissertations Reviews in Ornithology, *Ardeola* reports any studies on ornithological issues presented in our country. The section is intended as an updated overview of the latest ornithological research performed mainly in Spain. In spite of the efforts of the editor to compile all the theses, we are aware that the collaboration of researchers (supervisors and doctorates) is needed to give a full view of ornithological research in Spain. We therefore invite the scientific community to report on their results (address: ardeola@seo.org). The Scientific Committee of SEO/BirdLife grants a biennial prize to the best Ph Dissertation included in this section. The prize is awarded in the corresponding Spanish Ornithological Conference. We are looking forward to hearing from you, also as proof of the relevance and quality of ornithological research in Spain.

Nota informativa:

Ardeola recoge en su sección Reseña de Tesis Doctorales en Ornitología aquellas tesis leídas en nuestro país que estudien temas ornitológicos con el fin de informar sobre las más recientes investigaciones desarrolladas, fundamentalmente en España, en este campo científico. A pesar de los esfuerzos que realizamos para reseñar todas las tesis concluidas, somos conscientes de que un registro completo y actual de las mismas requiere de la colaboración de los investigadores (directores y doctorandos). Por ello invitamos a todos aquellos implicados en la realización de tesis en ornitología a que nos informen de sus resultados (dirección: ardeola@seo.org). El Comité Científico de SEO/BirdLife otorga con carácter bienal un premio a la mejor tesis doctoral reseñada en esta sección, que es entregado en el Congreso Español de Ornitología correspondiente. Esperamos vuestras noticias como buena señal de la pujanza de la investigación ornitológica en nuestro país.

Universidad de Alcalá de Henares

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[Wintering gulls as key vectors for dispersal of seeds, nutrients and contaminants in Andalusia.](#)

[*Gaviotas invernantes como vectores de transporte de semillas, nutrientes y contaminantes en Andalucía.*]

Key words: connectivity, Fuente de Piedra, guanotrophication, heavy metals, rice fields.

Palabras clave: arrozales, conectividad, Fuente de Piedra, guanotroficación, metales pesados.

Abstract:

Ecosystems services provided by waterbirds are diverse, and processes such as seed dispersal and biovectoring are among the most important ones. Due to global change, those services may become “disservices” if the seeds dispersed by waterbirds are inconvenient (e.g. weeds), or if the nutrients and contaminants are biovectored to wetlands that are already vulnerable to global change. Previous studies have shown the role of waterbirds on ecosystem services, but new GPS tracking technologies allow making more realistic quantification of such services. In this PhD thesis, I focus on the role of the Lesser Black-backed Gull *Larus fuscus* on seed dispersal and biovectoring at Andalusian scale. The availability of wintering detailed GPS movements, along with the species capacity to exploit several habitats, make this gull a good model species. In Chapter 1, the combination of GPS movements with network analyses allowed the creation of a connectivity network with the most frequently exploited habitats by the Lesser Black-backed Gull. In this way, I could determine where and in which frequency the different connections between the most im-

portant habitats were occurring. Therefore, those connections were involved in seed dispersal and biovectoring processes. Landfills and rice fields are the most important habitats to maintain the connectivity generated by gulls, and the connections in which aquatic systems act as a final source are especially relevant. Most of the connections occur within a 60km range, and, thus, different functional units within Andalusia may be created. Within such distance, biovectoring and dispersal processes are more likely to occur. Chapter 2 is focused solely in Doñana rice fields and it compares the dispersal potential of two generalist species that feed within the rice fields in the same way: the Lesser Black-backed Gull and the White Stork *Ciconia ciconia*. Faeces and pellet analyses and germination experiments under laboratory conditions showed that the community of plants dispersed is extense (21 taxa, including weeds). However, there was no great variation in the community of plants dispersed by the two bird species, despite the differences in body mass. After determining the main weed species dispersed by gulls, the objective of Chapter 3 is to combine GPS gull movements with seed retention times (obtained theoretically and experimentally with captive gulls) to generate spatial seed dispersal models taking Doñana rice fields as a starting point. Due to the vast cultivated area, high percent of the seeds were deposited within the rice fields, so gulls may have an important role dispersing weeds and homogenizing the weed community. Other seeds were deposited outside the rice field area, with dispersal distances up to 150km. Taking into account waterbirds for plant dispersal distances has important implications in species connectivity between suitable habitats as well as weed dispersal towards other agricultural environments. Chapter 4 aims to quantify the external nutrient loading to Fuente de Piedra Lake (Málaga, Andalusia) by the Lesser Black-backed Gull. Through

the combination of GPS data with nutrient analyses of total nitrogen and phosphorus in gull faeces and pellets, the quantity of nutrients loaded to the lake were estimated. GPS data were used to calculate the time that gulls spent in the lake during several years, but also to correct countings of gulls that departed earlier and were not included in census data. Four landfills in the surroundings were the main foraging sites for gulls in the region, and thus, the main source of such external nutrients. Finally, Chapter 5 applied faecal analyses to determine the role of gulls as bioindicators of environmental exposure to heavy metals. There were important variations in heavy metals concentrations in faeces along sites, which would be related to the pollution exposure of the area. Furthermore, the previous nutrient model from Chapter 4 was adapted to quantify the external input of heavy metals into Fuente de Piedra Lake. Long-term heavy metal deposition may be of importance to the lake dynamics.

Academic year: 2020-2021.

**Universidad Autónoma de Madrid /
Museo Nacional de Ciencias Naturales
(MNCN-CSIC)**

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The role of olfaction in the relationship between birds and their environment.

[Papel del olfato en las relaciones de las aves con su entorno.]

Key words: antipredator behaviour, avian olfaction, foraging, herbivore-induced plant volatiles, predator chemical cues.

Palabras clave: búsqueda de alimento, comportamiento antidepredatorio, ecología química de las aves, señales químicas de depredadores, volátiles inducidos por herbivoría.

Abstract:

Birds can detect odours to obtain information about their environment and respond adaptively in several ecological contexts. The ability to use the sense of smell to detect and respond to chemical cues of prey and predators is essential for the survival of birds. Therefore, natural selection has tended to design efficient foragers and predator avoiders because foraging and predator avoidance are major determinants of the fitness of birds. This thesis considers birds both as predators and prey, providing valuable information about the chemical ecology of birds. Birds have developed different methods for prey location to maximize their foraging effort and increase their fitness. This thesis studies the role of chemical cues in multi-trophic interactions involving trees, insects and insectivorous birds, and whether birds are also able to detect the chemical cues emitted by the prey to locate them. Plants emit herbivore-induced plant volatiles (HIPVs) when they are attacked by herbivorous arthropods to attract natural enemies of herbivores, and previous studies have suggested that insectivorous birds can detect the HIPVs and use them for prey location. However, our results showed that neither insectivorous adult birds nor inexperienced nestlings were attracted to trees treated with methyl jasmonate (MeJA), a phytohormone involved in the development of the defence response of plants and in the release of HIPVs (Chapter 1). Thus, further studies are needed to disentangle whether the potential differences in the emission of volatiles between herbivore-infested plants and plants treated with MeJA can explain the lack of attraction of bird predators to MeJA-treated Pyrenean Oak trees *Quercus pyrenaica*. We also show that insectivorous birds are able to detect the pheromones emitted by winter moth *Operophtera brumata* females to attract males, exploiting the prey pheromones as a method of prey location (Chapter 2). Therefore, this result adds birds

to the list of predators that are able to eavesdrop the chemical cues emitted by their prey for mate attraction. We have also explored in depth the ability of birds to detect the chemical cues of predators to accurately assess the risk of predation and adjust their antipredatory behaviour accordingly. Previous evidence suggests that birds in captivity are able to detect predator scents and avoid roosting in nest boxes containing such cues. We tested whether birds also show this avoidance response under natural conditions. We found no differences in the use of nest boxes for roosting in relation to the predation risk perceived (Chapter 3). In natural conditions, territory maintenance or thermoregulatory benefits of roosting in nest boxes may overcome the perceived risk of predation when only predator chemical cues are present. Birds have also developed different behavioural strategies to reduce the risk of predation during the reproduction. For example, many bird species cover their eggs to hide them from predators. Egg covering as an antipredator behaviour has been generally studied on bird species that nest in open areas, but some cavity-nesting bird species also cover their eggs. We analysed whether egg covering is an antipredator strategy in a cavity nester species. We simulated the visit of a predator to the nest by introducing chemical cues of a predator inside the nest box during the laying period. Birds exposed to predator chemical cues in the nest covered their eggs more frequently than birds exposed to an odorous control (Chapter 4). We found that egg covering behaviour may have evolved an antipredator strategy to reduce the risk of egg predation and increase the reproductive success in cavity nester birds. This thesis also shows that birds modified their parental behaviour when they detected predator chemical cues inside the nest, exhibiting intersexual behavioural differences in the risk afforded when taking care of nestlings. When parents were exposed to predator chemical

cues, females assumed greater risk than males. Differential investment in the reproduction may explain intersexual differences in risk taking behaviour, as females invest more time and energy than males in nest-building, laying and incubation. Therefore, the value of nestlings may be higher for females than for males and females assume greater risks to ensure nestling growth (Chapter 5). This thesis also tests the threat sensitive hypothesis that suggests that natural selection may have favoured the assessment of predation risk by integrating all information available from all predator cues to adjust the degree of antipredatory behaviour of animals. Our results show that birds were able to detect the behavioural cues of predators and exhibited greater antipredatory behaviours when exposed to a live predator than to a stuffed model with chemical cues (Chapter 6). This result supports the threat sensitive hypothesis. In summary, this thesis provides new evidence about the use of olfaction by birds in multiple ecological contexts, and it shows how birds have developed different strategies to solve two of their main needs: foraging and predator avoidance.

Academic year: 2019-2020.

Universidad Autónoma de Madrid

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[The role of social relationships in territorial and colonial female passerines.](#)

[El papel de las relaciones sociales en hembras de paseriformes territoriales y coloniales.]

Key words: extra-pair paternity, passerines, repeatability, sexual conflict, social interactions.

Palabras clave: conflicto sexual, interacciones sociales. Passeriformes, paternidad extra-pareja, repetibilidad.

Abstract:

Explaining behavioural diversity and its origins is an historical challenge for biologists and the main focus of research for classical ethology and for behavioural ecology. The main objective of this thesis is to increase our knowledge about the influence of social environment on reproduction, under an evolutionary perspective and through a largely experimental approach. This has been achieved by studying the effect of different types of social interactions between individuals of the same or opposite sex on different reproductive processes such as incubation or copulatory behaviour by emphasizing the role of females. We have used two model bird species with different social and reproductive systems, in captivity and in the wild: the Pied Flycatcher *Ficedula hypoleuca* (only studies in the wild), which is a territorial species, and the House Sparrow *Passer domesticus*, which is a gregarious species. This offers a broader perspective on passerines and on their study methodologies. Since nesting cavities are a scarce resource for hole nesters, there is strong competition for them during the breeding season. Their availability thus exerts a strong selective pressure during the incubation period. In the context of our first experiment (Chapter 1), it was observed that a drastic reduction of the wing patch in Pied Flycatcher females of the experimental treatment, caused higher values of vigilance against a simulated territorial intrusion by another female, decreasing their levels of incubation. Thus, wing patches may transmit information on female social status, mediating their interactions in contexts of intra-sexual competition. This would allow them to maintain high levels of incubation attendance by reducing the need for surveillance. Thus, these female plumage signals would be the result of social selection during breeding. In socially monogamous species, cases of extra-pair paternity (EPP) are frequent as the product of female copulations with other males rather than their mate. Although there

are numerous studies on patterns of EPP, there is still no consensus on the reasons for its great variability between species and individuals. Through our second experiment (Chapter 2) in Pied Flycatchers we found that an experimental reduction in female wing area during the fertile period, which presumably caused a decrease in their flight ability, led to an increase in EPP levels compared with control females. In addition, in a third experiment (Chapter 3) on the same species, it was observed that the increased mass of experimental females caused by an induced drastic reduction in nest building costs, produced an increase in EPP levels compared with control females. Considering that flight capacity (positively related to wing area and negatively associated with female body mass) is presumably linked to the capacity of females to avoid unwanted copulations by extra-pair males, our experimental results suggest that EPP can be the product of a sexual conflict which turns to the advantage of extra-pair males in some situations. The social context is a key element during the reproductive period, since individuals establish relationships with conspecifics in order to feed, defend territories and mate. In Chapter 4, we studied the relative importance of the social environment in EPP for Pied Flycatchers by analysing its individual inter-year repeatability. In addition, we studied the influence on EPP of individual features of territorial males and females such as age, plumage coloration and morphology, as well as contextual variables like breeding density or synchrony. The absence of inter-year repeatability in both males and females for EPP pointed out that variation in the social context in which sexual interactions occur may reduce the influence of individual traits. Personality affects different individual behaviours, which in turn have effects on fitness. For a trait to be considered part of personality, it must be consistent within individuals and differ among them. In Chapter 5 we studied individual consistency in socia-

bility traits of House Sparrows. Sociability of individuals was measured through their interactions with others inside the social network of the population, in different contexts and at different time scales by using social network analyses new tools. The presence of individual repeatability (intra-individual consistency) in sociality measures makes them ideal personality traits. Finally, the relationship found in Chapter 6 between sociality and the incidence of EPP in House Sparrows, supports the idea that sociality can be considered part of a strategy for females to cope with their social environments and probably thereby increase their fitness. The relative importance of individual characteristics of both males and females on the one hand, and the influence of the social context on the other, should be considered as key factors in determining the resulting behavioural reproductive patterns.

Academic year: 2020-2021.

Universidad de Barcelona

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Spatial ecology and migration of *Calonectris* shearwaters: new insights from Spanish populations revealed by biologging.

[*Ecología espacial y migración de las poblaciones españolas de pardela cenicienta: nuevos conocimientos obtenidos por seguimiento remoto.*]

Key words: at-sea behaviour, movement ecology, ocean sentinels, remote tracking, seabirds.

Palabras clave: aves marinas, centinelas del mar, comportamiento en el mar, ecología del movimiento, seguimiento remoto.

Abstract:

The revolution in *biologging* and satellite telemetry technologies in the last two decades

has led to a new era in seabird research. This thesis brings new insights into the spatial ecology and migration of the Cory's and the Scopoli's shearwaters (*Calonectris borealis* and *C. diomedea*, respectively), offering a comprehensive overview of these topics for the Spanish populations of these model species. In particular, the thesis provides new knowledge about the movement patterns, at-sea behaviour and the marine environment used year-round, through the use of GPS loggers and light-level geolocators, altogether illustrating the potential and applications of *biologging* in seabird research and conservation. To do so, we address different questions aimed to evaluate the role of environmental features, fisheries, and breeding constraints in the foraging strategies and at-sea behaviour of tracked birds. We found that female Scopoli's shearwaters generally attended fisheries less than males, and both sexes associated less to fishing boats during unfavourable conditions. Sea surface temperature likely plays a major role in individual decision-making: we found that birds may use this environmental feature to decide foraging trip destination. Moreover, we found both an interannual variability in foraging trips, likely due to environmental fluctuations, and variability at intraannual scale, likely due to the different constraints over the breeding period. We explored seabird behaviour from novel ways, deriving simple metrics that may enhance the use of seabirds as sentinel species. Last, we unveiled the role of individual differences in trophic ecology, and discussed the implications of such differences in the use of seabirds to monitor long-term fluctuations in a complex upwelling ecosystem. This thesis compiles and summarises the previous knowledge of the Spanish populations of Cory's and Scopoli's shearwaters, and extends it with novel insights. Finally, the role of seabirds as indicator species is discussed from a cross-cutting perspective, particularly considering

the use of *biologging* to enhance their suitability as ocean sentinels within the framework of ecosystem-based management.

Academic year: 2020-2021.

Universidad Complutense de Madrid

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Feeding in the garbage: physiological and microbiological consequences of using landfills as food resource in the White Stork (*Ciconia ciconia*).

[*Comer en la basura: consecuencias fisiológicas y microbiológicas de usar los vertederos como fuente de alimento en la cigüeña blanca (Ciconia ciconia).*]

Key words: landfills, microbiology, oxidative stress, telomeres, White Stork.

Palabras clave: cigüeña blanca, estrés oxidativo, microbiología, telómeros, vertederos.

Abstract:

This PhD thesis aimed to establish if the use of landfills as a food resource by White Storks, which could be judged positive a priori in view of the population increase, could have any negative effects on the health status of nestlings. For this purpose, we first evaluated (Chapter 1) the nutritional status, liver and renal function, oxidative stress balance and the presence of pathogens in individuals fed with different proportions of food from landfills. We found that, in fact, the higher the proportion of food from landfills the better the nutritional status, indicating higher food intake. Hepatic and/or renal function were not affected when using this food resource. Also, oxidative stress balance, which is particularly sensitive to damage by the potential occurrence of pollutants in the landfill, suggested a hormetic

response, i.e., an increase in defences to cope with limited damage without compromising the organism. Landfill foraging storks also had a higher prevalence of antibiotic resistant *E. coli*, which could be a problem both for the health of the storks and for the transmission of these microorganisms to other wild species, livestock, and humans. Second, we tried to confirm previous results at a much larger scale by increasing the number of colonies under study, and more importantly, by verifying if the benefits of feeding in landfills were consistent from year to year. We confirmed (Chapter 2) a better nutritional status of nestlings fed with food from landfills during the two years of study, as well as the apparent lack of affectation on hepatic and/or renal systems. However, the response of the oxidative stress balance varied among years, because of dietary antioxidants and the need of natural food after hatching (1-15 days). Yet, food from landfills never biased negatively the oxidative stress balance. This suggests that, despite the year, the potential damage could be perfectly counteracted by the nestlings. An easier monitoring of the health status of the individuals in these colonies in the future requires finding some external surrogates of the use of landfills, making the collection of data less invasive and less costly in terms of time and money. We found (Chapter 3) that both body condition and the redness of legs were affected by food provisioning from landfills but with an opposite trend: while the higher amount of food resulted in a better body condition, redness of legs decreased given the lower amount of carotenoids in food from landfills. These results revealed at least the short-term benefits of the use of landfills as a food source. However, we ignored if this behaviour would have carry-over effects, as early-development conditions can influence different life-history traits later in life. Since monitoring these individuals during their entire life is unfeasible, we studied telomeres

as a proxy to this effect because their length has been suggested to be responsible for the link between early-life conditions and potential lifespan, and because their rate of attrition could be altered by external factors that act through oxidative stress balance. We approached this question experimentally, and our results showed that the administration of antioxidants in free-living individuals maintained telomeres longer, suggesting that these individuals may suffer a lack of dietary antioxidants, which in turn could affect their lifespan. The use of these multidisciplinary approaches to the study of the status of certain species, such as the White Stork, is becoming increasingly necessary due to progressive globalization, which will lead to a greater number of interactions between wildlife and humans.

Academic year: 2020-2021.

Universidad de Extremadura

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Comparative temporal study of the years of maximum and minimum biodiversity of birds in the Arrocampo reservoir of the Almaraz nuclear power plant (Cáceres).

[Estudio comparativo temporal del año de máxima y mínima biodiversidad de aves en el embalse de Arrocampo de la central nuclear de Almaraz (Cáceres).]

Key words: aquatic birds, biodiversity, dam, trophisms, trophic niche.

Palabras clave: aves acuáticas, biodiversidad, embalse, nicho trófico, trofismo.

Abstract:

The dams, ponds, etc., are water reservoirs often built by humans for electrical production, water supply, irrigation, navigation, fishing, bathing, and recreational purposes, etc., and are usually accepted as a positive

income for the area that houses them. This paper studies the biodiversity of birds in the Arrocampo reservoir in the years when the maximum and minimum number of bird species (2009 and 2010 respectively) were observed after more than 35 years of study. This basin is unique in the world, because it was created for cooling the turbines of the Almaraz nuclear power plant (Cáceres). Its temperature and volume of water is very constant, what allows permanent feeding, breeding and housing for insects, fishes, amphibia, reptiles, birds, mammals, whose communities are characterised by their stability, but with relevant temporal dynamics. Since the construction of the dam, in 1976, it holds important populations of many resident bird species and has become a Special Protection Bird Area (SPBA). This thesis aims to determine the causes of the variation in the occupation of this reservoir by birds. 2009 was one of the years with the lowest precipitation on record since the creation of the Almaraz Nuclear Power Plant, while 2010 was a very rainy year (with twice as much rainfall as in 2009). In the study, both the bird presence data and the climatic data were subjected to various analyses, sorting and classification, seeking to find the possible relationship or effect between the composition of the community, the spatial component (derived from the sectorization of the reservoir) and the meteorological data (which come from both AEMET observations and from the nuclear power plant itself). The trophism of the bird species and the trophic niches occupied by each of them in the study area was also studied. Our study evidences the need to establish techniques of observation, data processing, selection of size, shape and quality of the reservoirs, to determine the quality of the habitats of the organisms to be studied. The results and conclusions obtained provide information that allows comparisons with other reservoirs and aquatic environments and generalizations of

interest for the valuation of nature, conservation and environmental impact assessment.
Academic year: 2017-2018.

**Universidad de Extremadura /
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Colour polymorphism in the Scops Owl *Otus scops*: linking melanic colourations, behavior and physiology in birds.

[Polimorfismo de color en el autillo europeo Otus scops: ligando coloraciones melánicas, comportamiento y fisiología en aves.]

Key words: animal behaviour, colour polymorphism, complex phenotype, melanic colouration, physiology.

Palabras clave: coloración melánica, comportamiento animal, fenotipo complejo, fisiología, polimorfismo de color.

Abstract:

This thesis delves into the mechanisms that promote phenotypic variation by studying colour polymorphism in a population of Scops Owl *Otus scops*. Polymorphism was demonstrated in this species; whose frequency distribution was constant in the period studied. Redness was associated with the amount of phaeomelanin, but the *MC1R* gene was not related to plumage colouration. Reddish-brown males took longer to return to the nest, having higher levels of corticosterone in feathers, but no differences were observed in females. It was suggested the existence of an integrated phaeomelanic phenotype dependent on sex. Intermediate females preferred males of intermediate colouration as a pair and showed a higher survival, other females were randomly paired. Mating appears to favour intermediate males

and survival appears to favour intermediate females, however, the proportion of intermediate individuals did not increase during the study period. Insects were 89.9% of the biomass contributed to the nestlings, being *Orthoptera* (69.7% of the prey) the most abundant prey brought mainly by males. Reddish-brown males fattened fewer grasshoppers under full moon conditions (i.e. high luminosity), maintaining the same feeding efficiency. Reddish-brown females fattened fewer grasshoppers regardless of moon phase. There appears to be a colour-dependent trophic segregation based on the variation of moonlight in Scops Owls. All the results suggest a complex colour polymorphism in this species that could be explained by natural and sexual selection acting simultaneously.
Academic year: 2021-2022.

Universidad de Jaén

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Monitoring of Tetraonid populations in the Pyrenees by non-invasive methods.

[Monitorización de poblaciones de Tetraónidos en los Pirineos mediante métodos no invasivos.]

Key words: abundance estimate, distance sampling, non-invasive sampling and genetic analysis, Rock Ptarmigan, Western Capercaillie.

Palabras clave: estima del número de individuos, lagópodo alpino, muestreo no invasivo y análisis genéticos, muestreo por distancias, urogallo.

Abstract:

Obtaining accurate estimates of the abundance of individuals is crucial for proper management of wildlife populations but it may be particularly difficult for some bird

species. The Western Capercaillie *Tetrao urogallus* and the Rock Ptarmigan *Lagopus muta* are two tetraonid species that were isolated in the southern European mountain ranges after the last glaciations. During the last years, few studies have been carried out to evaluate the efficiency and accuracy of the methodologies used to estimate the population size of these bird species. The main objective of this study was to evaluate the available methodologies to estimate the abundance of Western Capercaillies and Rock Ptarmigans, and to propose alternative and more precise estimation methods. Regarding the Western Capercaillie, the number of males detected from singing counts, the traditional monitoring method for this bird, was compared with the number of individuals detected from non-invasive sampling (faeces) and genetic analysis. Since singing counts tend to underestimate the number of males in a lek, the method based on non-invasive sampling and genetic analysis can become a good monitoring alternative. Moreover, we assembled and described the mitochondrial genome of the subspecies *T. u. aquitanicus*, endemic to the Pyrenees, from a low-coverage sequencing of its genome. The mitochondrial genome of the Western Capercaillie was similar in size and organization to the ones described for other Galliformes species. Furthermore, we confirmed the phylogeny established for the Order Galliformes with the phylogenetic analyses performed using the mitogenome. Concerning the Rock Ptarmigan, using a database of Point-counts of singing males carried out between 2003 and 2017, densities were calculated with two different methodologies: Plot Sampling and Distance Sampling. We found that Distance Sampling is more reliable (i.e. it provides higher and more precise densities) than Plot Sampling for estimating the densities of this species from singing males Point-counts. In addition, in three study areas, densities obtained from Point-counts and Distance Sam-

pling, and by non-invasive sampling (faeces) and genetic analysis were compared. The latter approach can be a good tool for monitoring the abundance of Rock Ptarmigan populations. Finally, the sex ratio of this species was estimated with two different approaches, using data from non-invasive sampling and genetic analysis, and using the hunting bag data. Data obtained with the first method yielded a balanced sex ratio of adult individuals. Moreover, results obtained from the hunting bag data may be biased due to intrinsic or extrinsic factors. In general, the non-invasive sampling and genetic analysis methodology developed in this study estimates more precisely the demographic parameters (number of specimens and sex ratio) than the traditionally employed methodologies (singing counts, hunting bag data). This methodology can be a good alternative to traditional counts, since it obtains more information, with a similar cost, and produces less disturbance to the individuals of both species.

Academic year: 2019-2020.

Universidad de León

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[Application of landscape genetics concepts to the conservation of mountain birds.](#)

[Aplicación de los conceptos de la genética del paisaje a la conservación de las aves de montaña.]

Key words: gene flow, landscape genetics, *Luscinia svecica azuricollis*, phenotypic plasticity, song differentiation.

Palabras clave: diferenciación del canto, flujo génico, genética del paisaje, *Luscinia svecica azuricollis*, plasticidad fenotípica.

Abstract:

Mountains are dynamic and complex socio-ecological systems of great conservation

value. Although they cover only 25% of Earth's land area, they hold more than 85% of the world's species of amphibians, birds and mammals, many of them being endemic. This high level of biodiversity is related to orographic and environmental complexity, but also to cultural use diversity, that have shaped highly heterogeneous and fragmented landscapes where important processes of genetic differentiation and speciation occur. Remarkably, mountain systems are under threat, as they are highly fragile and vulnerable against both climatic and land use changes. The mountains of the Iberian Peninsula are located between the two main biogeographical regions of southern Europe, which means that they are home to species of both Mediterranean and Eurosiberian origin. In addition, these mountains are the current distribution limit for many animal and plant species and have served as a refuge during the last glaciations. These particular circumstances make them ideal scenarios for the study of genetic and phenotypic diversification as the origin of speciation processes. Therefore, they have been chosen as the case study in this thesis to evaluate, at different scales, the influence of landscape heterogeneity and dynamics on the genetic and phenotypic diversification of the Bluethroat *Luscinia svecica*, a long-distance migrant passerine. At the European scale, we aimed to analyse the phylogenetic relationships between the subspecies that constitute the subspecific complex of *Luscinia svecica*. At the Iberian scale, the goal was to understand the role of landscape in genetic and phenotypic differentiation in the breeding populations of the subspecies *Luscinia svecica azuricollis*. The understanding of those processes is fundamental for the design of realistic conservation policies ensuring the long-term genetic diversity and resilience of species to environmental changes in the future. The Bluethroat breeds throughout Europe, Asia and Alaska in a wide variety of habitats located from the

sea level up to 4000m a.s.l. The species is mostly associated with alpine and subalpine low scrublands and wetlands, but also breeds in salt meadows. There are 10 subspecies that constitute a subspecies complex described on the basis of differences in body size and plumage coloration of males and also on divergences in breeding habitat, migration route and wintering area. Nevertheless, the taxonomic classification of this subspecies complex is not exempt from controversy. The Iberian subspecies *azuricollis* is located at the southernmost edge of the species' range in Eurasia, where it breeds in broom and holm oak shrublands. This subspecies is genetically and phenotypically well differentiated from the other subspecies and shows higher genetic differentiation than their north-European counterparts. At the European scale, we provided new evidences supplementing the existing knowledge about the singularity of Iberian Bluethroats within the *Luscinia svecica* subspecies mosaic, according to biometric and plumage coloration pattern divergence with the closest subspecies *cyaneacula* and *namnetum*. At the Iberian scale, we found evidence of limited gene flow among populations, reduced effective population size and signs of genetic erosion, which may be related to processes of genetic drift due to reproductive isolation and strong breeding site fidelity. Genetic structure was better associated with landscape resistance, rather than with geographic distance. The highest values of habitat suitability corresponded to areas where vegetation remained mostly stable during the two decades prior to bird surveys, with low annual precipitation and spring temperature, being the relationship between gene flow and presence of intervenient habitat among populations linear or quasi-linear. The morphological characters (biometric and morphometric) varied significantly between localities and genetic groups. The greatest divergence in morphology corresponded to the Central

system population, the most geographically and functionally isolated genetic group. Finally, Iberian breeding Bluethroats showed important spatial variations in song complexity and structure. A multitude of deterministic and stochastic forces are involved in song differentiation, but the factors with the most significant effect in this case were body size, vegetation type, habitat quality and geographical distance. Bluethroat Iberian populations should be considered as a priority in the design of conservation policies aimed at preserving the genetic diversity and resilience of the species to long-term environmental changes in the Eurasian context. Management actions that could prove beneficial to increase suitable habitat between localities include wildfire prevention and extensive livestock farming to maintain open spaces and limit forest expansion and landscape homogenization. Management for promoting fine-grained semi-natural mosaics of shrub/heaths and pastures will also benefit other species of EU Community Conservation Interest, such as the Grey Partridge *Perdix perdix* subsp. *hispanensis* or the Broom Hare *Lepus castroviejoi*, that, along with the Bluethroat, are the flagship species of the biological community inhabiting such landscape mosaics in the northernmost Iberian mountain systems.

Academic year: 2019-2020.

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The Barn Owl *Tyto alba*: Influence of captive breeding in adult behaviour and indirect assessment of population trends in Navarre (Spain).

[*La lechuza común Tyto alba: influencia de la cría en cautividad en su comportamiento*

adulto y valoración indirecta de su evolución poblacional en Navarra.]

Key words: Barn owl, behaviour, captive breeding, population, *Tyto alba*.

Palabras clave: comportamiento, cría en cautividad, lechuza, población, Tyto alba.

Abstract:

The Barn Owl (*Tyto alba*, Scopoli, 1769) is a strigiform bird of the Tytonidae family. The species is closely related to human rural environments, and its populations have remained in a good state for millennia. However, changes in agricultural practices in recent decades may, in part, be responsible for the apparent general population decline reported in Europe, and in Spain in particular. The Autonomous Community of Navarre is a region in the north of the Iberian Peninsula characterized by significant latitudinal differences in biotope and societal landscapes. In Navarre the presence of the Barn Owl has been common but, indeed, a population decline has been recently detected. The nocturnal and elusive habits of this species makes accurate sampling difficult. However, unlike other raptor species, the Barn Owl generates easily recognizable pellets of an adequate size for diet analysis, explaining why most studies to date focus on their diet, as well as on the communities of rodents and insectivores on which the species feeds. Pellets are therefore indicative of the presence of the species in a certain area, so they can also be used, alongside direct sampling, to indirectly assess the status of their populations. In a scenario of population decline of a key species in the ecosystem, it is common to develop programmes for the reintroduction of captive-bred individuals to the natural environment. However, these breeding programmes often encounter challenges in the adaptation of captive-bred individuals to their natural environment associated with abnormalities in adult behaviour. In particular, neophobic behaviour, or fear of novelty,

can play a crucial role as, although important for survival, in excess it can harm the adaptation of captive-bred individuals to new living conditions. This thesis contributes to the knowledge of two important aspects of the biology of the Barn Owl: (i) providing information on its population in Navarre in recent decades using indirect measurements on the presence of this bird in the territory; and (ii) studying the effect of different captive breeding methods on key behavioural aspects in the development of Barn Owls (from birth to independence). For the first question, two complementary studies were conducted: first, historical records of Barn Owl pellets extracted from research on small mammal communities in Navarra were resampled, visiting 453 different places; second, surveys of the local human population across 103 different towns were carried out to gain knowledge on their perception of the biology and population status of the species. For the second question, two additional studies were conducted in which individual Barn Owls were bred in captivity under varying degrees of human-parental imprint, and subsequently studying their behaviour when exposed to different environments and humans (from familiar to unfamiliar; first study), as well as their hunting behaviour when exposed to their first prey (second study). To this aim, 690 hours of video were recorded and analysed. The analysis of the localities with pellet records determined that: (i) nesting and refuge sites have changed in the last two decades, mainly due to the closure of church belfries and vaults; and (ii) as a consequence of the abandonment and collapse of traditional barns, the species is increasingly having fewer options for shelter and reproduction. This is in consonance with the inhabitants' opinion of the sampled areas: respondents from areas in which the nesting sites are still close to urban centres, are more likely to answer that the species is not in decline. In contrast, inhabitants from those

areas in which the opposite occurs, were more likely to report a population decline in the past 10 to 20 years. Behavioural experiments in captivity show that developmental changes occur between 15 and 20 days of life that determine the association that individual Barn Owls make with objects in their environment. Thus, after this age, they display greater neophobic behaviour as a greater degree of novelty is incorporated into the environment where trained routines are carried out. Breeding method also influences hunting behaviour: individuals raised by humans tend to exhibit greater exploratory behaviour than those raised by their parents, which, in contrast, reduces their precision in the capture of their first prey. Overall, results from this thesis show that the rural environment is changing in such a way that Barn Owl populations can be negatively affected, so it is necessary to deepen the study of measures that counteract this effect. In this line, research on how adult behavioural patterns are influenced by early life environments is of particular importance, in order to improve the survival of reintroduced individuals that have been bred in captivity.

Academic year: 2020-2021.

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[Ecological, demographic and genetic constraints on the conservation of the Lear's Macaw.](#)

[Restricciones demográficas, ecológicas y genéticas en la conservación del Guacamayo de Lear.]

Key words: endangered species, invasive species, parrot conservation, population ecology, population genetics.

Palabras clave: conservación de loros, ecología de poblaciones, especies amenazadas, especies invasoras, genética de poblaciones.

Abstract:

The Lear's Macaw *Anodorhynchus leari* is endemic to the Caatinga biome (tropical dry-forest in NE Brazil) and is listed as globally Endangered in the IUCN Red List. This species uses sandstone cliffs for breeding and roosting communally and feeds mostly on fruits of the Licuri Palm *Syagrus coronata*. The global breeding population is concentrated in two close localities and ca. 80% is constituted by non-breeding individuals, probably due to a large population decrease and range contraction in the past decades but is currently sharply increasing. If the population does not expand geographically, the continuous increase could result in the saturation of environmental resources and generate negative density-dependent effects. Thus, in this thesis we used a multidisciplinary approach to investigate the population demography, potential genetic constraints and threats that may affect the conservation, recovery and expansion of this species. We estimated the recent population trend by employing a detection-based analysis, developing a binomial – negative binomial N-mixture model to replicated roost counts done by Brazilian Environmental Agency CEMAVE/ICMBIO (Centro Nacional de Pesquisas para a Conservação das Aves Silvestre/Instituto Chico Mendes de Conservação da Biodiversidade) from 2001 to 2014. Results suggest that population size is much larger than previously thought and that it increased 333% in that period. We make recommendations for an improved design for population monitoring programs. Considering the demographic history, potential genetic constraints in the remaining population are a concern. Therefore, we described fifteen unlinked informative species-specific microsatellite primers

developed from wild individual samples for individual identification of related wild nestlings to perform population genetics research. Selected polymorphic microsatellites were used to genotype non-invasive samples (molted feathers) and estimate genetic diversity and effective population size across the current range of the species, that includes new localities found after the population expansion (5 localities sampled in total). We found molted feather sample repetition (i.e. multiple feathers from single individuals), moderate levels of genetic diversity, and no evidence of strong inbreeding in any of the five localities surveyed. Results also showed a wide genetic admixture among all localities and overall differentiation was low. The average adult sex-ratio based on non-invasive sampling is male-biased (0.61), underscoring the need for further research on the primary and secondary sex-ratios of the immature population. We searched for the causes of local extinctions and the current threats that the population could be facing in an expansion process. By means of road-surveys across the current and historic distribution of the species, local knowledge (112 interviews with elderly villagers/farmers) and field observations, we confirmed the location of two recolonized breeding areas (at sandstone cliffs), new communal roosts (at sandstone cliffs and, unusually, at large trees), and other six localities from where the species disappeared. We also compiled past and current threats, assessed habitat traits in occupied and unoccupied areas, and finally developed habitat suitability models for the Lear's Macaw and its main food resource, the Licuri Palm. The overlap of these two models allowed identification of optimal areas for the Lear's Macaw expansion, where future conservation actions should be concentrated. One of the highlighted threats identified was the presence of invasive Africanized honey bees *Apis mellifera* in the Caatinga. We assessed the competition for cliff cavities used

by nesting Lear's Macaws and also by invasive Africanized honey bees. We recorded > 100 hives in the Lear's Macaw breeding sites, with higher infestation in areas recently recolonized by the macaws. We experimentally treated hives with permethrin and, when feasible, we removed the combs and applied an insecticide (fipronil) to deter Africanized honey bee recolonization of the cavities. Our experimental hive treatments were effective, allowing nest recruitment and local breeding population increase of Lear's Macaws by 71%. We recommend intensive and continued Africanized honey bee hive eradication to enhance habitat restoration and facilitating Lear's expansion into historical areas. The data generated by this thesis will be decisive for the design of management strategies and conservation of this endangered species.

Academic year: 2019-2020.

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[The overlooked dimensions of domestic parrot poaching in the neotropics.](#)

[Las facetas ignoradas de la captura y comercio ilegal de loros a nivel doméstico en el neotrópico.]

Key words: defaunation, parrots, pets, poaching, wildlife trade.

Palabras clave: captura ilegal, comercio ilegal, defaunación, mascotas, loros.

Abstract:

Defaunation processes have important ecological consequences. Several factors can lead to defaunation, such as climate change, habitat loss or direct persecution by humans. Illegal wildlife trade represents one of the most important causes of defaunation and a serious threat to a large number of vertebrate species worldwide. Parrots (Psittaciformes) are one of the most threatened groups of birds on the planet, with 28% of their species under

threat according to IUCN criteria. Habitat loss as a result of deforestation and agricultural intensification, and illegal wildlife trade are among the main threats to this group. Until recently, attention on illegal trade has focused on the international level, overlooking the role that illegal trade plays at the domestic level. A recent study on several Neotropical parrot populations revealed that illegal trade at the domestic level was a major threat. In addition, studies in several markets in South America found that thousands of parrots are sold each year to supply local demand for parrots. Understanding the significant threat that illegal domestic trade can pose is a priority for the conservation of parrot species worldwide (Chapter 1). This thesis addresses some overlooked aspects of the illegal domestic parrot trade in the Neotropics. For this purpose, extensive fieldwork has been carried out covering more than 40,000km in 12 countries. By combining the fieldwork data with those related to wildlife markets, more precise figures on the volume of parrots poached annually in Bolivia were estimated. In addition, the ages at which parrots were lost (killed, sold or escaped) highlight the significant high turnover of poached parrots in this country (Chapter 2). On the other hand, by using a new statistical tool (the Savage selection index) this thesis sheds light on one of the most controversial questions related to this important threat to parrots, whether it is an opportunistic activity or not. Thus, parrot poaching targets species positively selected by people based on certain attractive characteristics, such as the ability to mimic human speech, size or color (Chapter 3). Illegal domestic trade has been overlooked in part because most illegal trade occurs outside wildlife markets, while most studies focus on these markets. However, although most poached parrots are kept locally or sold in nearby areas, some individuals are moved to distant areas. Species positively selected by people according to the selectivity

index are moved more than unselected or negatively selected species, confirming that people's preferences have an important impact (Chapter 4). The extent to which habitat loss poses a threat to parrots compared to poaching has not yet been assessed. Large-scale studies assessing human transformation in combination with satellite imagery have shown that parrots are able to adapt to some degree of habitat transformation, but are severely affected by illegal domestic trade (Chapter 5). Indeed, several parrot species thrive well in human-modified habitats, including cities. However, although cities may represent a suitable habitat for parrots and a release from human pressures, such as habitat destruction or poaching, the ecological roles that parrots can play in ecosystems are lost (Chapter 6). Finally, illegal domestic trade may have other unexpected impacts by bringing wild animals – prone to have pathogens or parasites – into contact with humans, facilitating zoonoses spillover (Chapter 7). The vast extension of this activity in the Neotropics makes it necessary to implement effective control measures combined with educational campaigns, not only for the conservation of the parrot species, but also to avoid problems for human health.

Academic year: 2020-2021.

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Trophic ecology of opportunistic species in a changing world: Exploitation of human origin resources by Yellow-legged Gull *Larus michahellis* in the Basque coast.

*[Ecología trófica de especies oportunistas en un mundo cambiante: Explotación de recursos de origen humano por la gaviota patiamarilla *Larus michahellis* en la costa vasca.]*

*[Espezie oportunisten ekologia trofikoa mundu aldakor batean: euskal kostaldean kaio hankahoriek *Larus michahellis* egiten duten giza jatorriko baliabideen ustiapena.]*

Key words: availability of anthropogenic resources, diet, GPS, mercury species, seabird.

Palabras clave: ave marina, dieta, disponibilidad de recursos antropogénicos, especies de mercurio, GPS.

Abstract:

Detailed analyses on trophic ecology allow determining how species depend on key feeding sources, which, in turn, makes it possible to quantify the adaptive capacity of generalist species to new resources when environmental changes affect food availability. Nowadays, the European policies aim to reduce the availability of food subsidies of human origin, such as fish discards or the existence of open-air landfill sites. This enables testing the effect of these changes in those animal species able to exploit such subsidies. The Yellow-legged Gull *Larus michahellis* is an opportunistic species that feeds on a wide variety of resources, including food of anthropogenic origin. The breeding population of the south-eastern Bay of Biscay also takes benefit from these resources and it is resident, so it relies on feeding subsidies in the area all the year round. This gives a good opportunity to evaluate the effect of the closure of several landfills in the region (promoted by the EU policies) on the trophic ecology of this gull species. Based on stable isotopes and mixing models, we found a significant decrease in landfill origin resources after the closure of these sites, which was compensated by a higher intake of terrestrial prey. We also detected high trophic variation among several breeding colonies located close to each other. Part of this variation was explained by the proximity of key anthropogenic feeding resources (landfills and fishing harbours). Specifically, the distance of the nearest fishing harbour showed a

stronger effect than the distance to the nearest landfill and models suggested that gulls located near harbours would benefit more from feeding in these sites. Besides, landfill effects were detected at greater distances, presumably because of their higher predictability. However, distance-dependent effects from either of these sites were observed during the breeding period. Such effects would become weaker after the breeding season when adult gulls are less linked to the colony. Therefore, from a management standpoint, EU policies towards the closure of open air landfills would have important consequences on both trophic ecology and demography of the Yellow-legged Gull. From the point of view of the long-term population viability, demographic adjustment of the population is expected in the following years if gulls are not able to find sufficient alternative resources. The effect of the ban of fishing discards promoted by the EU is more difficult to forecast, as gulls seemingly do not consume most fish prey from the fishing activity offshore, but presumably by active fishing or from discards and fishery waste taken directly in fishing harbours. Additionally, we found that the trophic ecology has consequences on the quality of the individuals. Gulls feeding on a higher proportion of marine prey showed a smaller red spot in the bill, which would result in lower reproductive success. Moreover, these birds also showed higher Hg concentration, including its toxic form methylmercury. Previous works have related foraging in a higher proportion of marine prey to better reproductive output and growth rates of chicks. However, our results suggest that marine prey may not be as beneficial as expected, at least regarding these mentioned aspects (smaller red spot that would be related with reproductive success and higher Hg concentration). In this work, high Hg exposure was detected in the Bay of Biscay and we propose that the Yellow-legged Gull is a suitable biomonitor for Hg, which would be in compliance with Minamata convention

on Mercury. Another aspect affecting the trophic ecology was the occurrence of very adverse meteorological conditions during the breeding period. We found that in very rainy and/or windy days, adult Yellow-legged Gulls equipped with a GPS device were not able to exploit all the feeding resources potentially available in their home range and this would have consequences on chick provisioning. Climate change, with presumably more rainy and/or windy days during the breeding period, might have negative effects on the reproduction of Yellow-legged Gulls. Finally, the flexibility of this species and its capacity to cope with changes in food availability and climate change, will be key aspects to determine the final consequences for the studied Yellow-legged Gull population in terms of spatial use and population dynamics.

Academic year: 2019-2020.

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The role of uropygial secretion and birds body odour on their interaction with mosquitoes and parasites.

[El papel de la secreción uropigial y el olor corporal de las aves en su interacción con mosquitos y parásitos.]

Key words: birds, haemosporidians, mosquitoes, uropygial secretion, volatile compounds.

Palabras clave: aves, compuestos volátiles, haemosporidios, mosquitos, secreción uropigial.

Abstract:

Mosquitoes transmit parasites and other pathogens causing important diseases that affect humans, wildlife, and domestic animals.

This is the case of malaria parasites, which may largely influence host population dynamics. However, the mechanisms affecting the interactions between mosquitoes, parasites, and vertebrate hosts are not fully understood, especially in the case of wild non-model species. The aim of this thesis is to assess the role of different bird chemical cues (uropygial gland secretions and body odour) in mosquito attraction and the effect of host infection by avian malaria parasites on these interactions. To better understand the dynamics of host-vector-pathogen interactions, I tested the host manipulation hypothesis, which argues that parasites may modify certain characteristics of their hosts to increase their transmission success. Thus, malaria infected birds would be more attractive to mosquitoes than uninfected ones, thereby enhancing the contact rates between parasites and insect vectors. However, the mechanisms underlying this differential attraction are still unknown. I studied the potential effect of parasite infections on the odours emitted by birds and how this may in turn affect the interactions with mosquitoes. Secretions of the uropygial gland are considered one of the main sources of bird odour, so the influence of parasites on bird-vector interactions could be driven by their effects on the composition of these secretions. I performed different studies to determine the potential factors affecting the composition of birds' uropygial secretions, including parasite infections, and subsequently, I tested the role of secretions and body odour in mosquito attraction. The overall composition of uropygial secretions of wild birds differed between sexes and age classes but neither avian haemosporidian parasites nor habitat type (forest and urban area) had a significant effect on the composition of the uropygial secretions. Further analyses revealed the presence of the pollutant dichlorodiphenyl-dichloroethylene (DDE) in uropygial secretions. DDE is mainly derived from the

dichlorodiphenyltrichloroethane (DDT) used decades ago. The relative proportion of DDE was higher in older and forest-dwelling birds. Overall these results support the role of both intrinsic and extrinsic factors in intraspecific variation in the composition of uropygial gland secretions. However, these results do not provide support for the potential effect of parasite infections on the composition of bird uropygial secretions. Based on the importance of the uropygial gland secretion as a source of bird odour, I evaluated the role of this secretion in the attraction of two species of mosquitoes with differential feeding patterns, namely the ornithophilic *Culex pipiens* and the mammophilic *Aedes caspius*. Both species of mosquitoes were similarly attracted to this stimulus (uropygial gland secretions + CO₂) than to the control (only CO₂) in a dual choice olfactometer, suggesting that the attraction of mosquitoes to avian hosts is not mediated by this chemical cue. Subsequently, I tested the role of *Plasmodium* infection in the attraction of *Cx. pipiens* mosquitoes towards both uropygial secretions and bird's body odours. *Culex pipiens* were more attracted towards the odour of *Plasmodium* infected than uninfected birds, while no differences were found in the attraction of mosquitoes when the stimulus tested was the uropygial gland secretion. These results suggest that *Plasmodium* modifies bird body odour, increasing the attraction of mosquitoes and therefore, rising its capacity of transmission to new vertebrate hosts. However, these effects are not driven by changes in the volatile fraction of the uropygial gland secretion. In sum, this thesis provides novel evidence into the complex mechanisms that drive the interactions between parasites, vectors, and vertebrates, and highlights the role of chemical cues such as the odour of birds in the attraction of mosquitoes to individuals infected by haemosporidians. These results may have important implications for the epidemiology of

Plasmodium in natural environments and open new questions for future studies on the identification of key components of bird's odours determining mosquito attraction.

Academic year: 2019-2020.

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Individual and environmental drivers of resource use in an endangered vulture: Integrating movement, spatial and social ecology.

[*Factores individuales y ambientales responsables del uso de recursos en una especie de buitre amenazada. Integrando ecología social, espacial y del movimiento.*]

Key words: Canary Islands, conservation biology, Egyptian vulture, GPS-tracking. *Palabras clave: alimoche, biología de la conservación, islas Canarias, seguimiento GPS.*

Abstract:

The study of animal movement enhances our understanding of the influence of spatial context on individuals and populations. This is especially important for species with substantial movement ability that wander routinely over large areas and encounter diverse human-mediated threats at different spatial scales. Vultures are long-lived scavenging vertebrates with delayed maturity and low fecundity, often exhibiting complex social behaviours. European and most of the Old World vulture populations have historically been closely dependent on the spatial distribution of human-provided resources. Currently, they are globally endangered and have suffered dramatic regional declines of up to 90%, mainly provoked by direct and indirect persecution, infrastructure development and a decrease in food resources. Effective vulture conservation requires a spatially-explicit understanding of how vultures cope with resource availability and human-induced transformation. In this thesis, we used spatial

data collected between 2013 and 2018 from 49 GPS-tagged Canary Egyptian vultures *Neophron percnopterus majorensis*. The bulk of this endemic subspecies is concentrated in Fuerteventura Island where it depends on extensive goat farms, currently changing towards semi-intensive and intensive regimes. In addition, this isolated and small population is seriously threatened by non-natural mortality, mainly due to accidents with power lines. Movement information is combined with individual characteristics, life-history stages, and detailed data on the spatial distribution of territories, feeding resources, and human facilities. Particularly, we examined i) drivers of the use of power lines, ii) foraging tactics according to spatiotemporal variation in food predictability and individual characteristics, iii) drivers of visits to livestock farms, and iv) farmers' perception about the target species in relation to the observed spatial behaviour. We found that the vultures' behaviour was influenced by the distribution, predictability and amount of feeding resources, as well as by the spatial distribution of conspecifics and sources of human disturbance. At the same time, individual attributes such as sex, age, territorial status or social rank interacted with environmental cues to shape movements involving a complex ecological network. Overall, vultures somewhat avoided humans by selecting farms and electric pylons far from roads or urban areas. Importantly, the predictable food resources provided by the main feeding station corresponded with an intensive use of electric pylons and farms in its proximity. However, the use of both resources was complex and based on individual traits and life-history stages. Territorial status and social position in the dominance hierarchy shaped sex-specific patterns of feeding preferences, with dominant breeding females, but not males, using predictable food more intensively and settling in nearby territories. The distribution of territories, in turn, affected

the selection of pylons and farms by both territorial and non-breeding individuals, highlighting the close interdependency and feedback between the spatial structuring of the population and the distribution of resources. Non-territorial individuals avoided resources located close to occupied breeding territories while territorial ones preferred those close to their nest, with these spatial constraints being less obvious during the non-breeding season. After disentangling the effect of those ecological factors on the intensity of use of electric pylons, we combined predictions with actual mortality showing that prioritizing mitigation measures for relatively few pylons could drastically reduce accidents. Finally, farmers perceived Egyptian vultures as the most beneficial avian scavenger on the island, but owners of larger farms (more often visited by scavengers but frequently more mechanised or intensified than smaller farms), were less aware of vulture presence on their properties. This suggests a potential influence of modern livestock practices on disconnecting people from ecosystem services provided by wildlife. Moreover, the consistency between awareness and GPS data decreased when vultures were less present on farms or in their surroundings, indicating that scarce and endangered species are more susceptible to misperceptions. Our findings are important in a context of rapid changes in traditional livestock practices and power development worldwide, offering sound scientific knowledge for informed management decisions. The complex network of ecological factors and patterns should be considered in the management of electric infrastructures, predictable and semi-predictable resources, or social actions for vulture conservation. General solutions ignoring the specific ecology of this species (i.e. population structure and the spatial distribution of territories, feeding sources or the human footprint) should be avoided since they could lead to

unbalanced impacts between population fractions compromising the effectiveness of management and conservation actions.

Academic year: 2019-2020.

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[Interactions between non-native parrot species and their recipient environments.](#)

[Interacciones entre especies de psitácidos exóticos y los nuevos medios que ocupan.]

Key words: animal-plant mutualism, biological invasions, impact, interspecific competition, Psittaciformes.

Palabras clave: competencia interespecífica, impacto, invasiones biológicas, mutualismo planta-animal, Psittaciformes.

Abstract:

Despite biological invasions are one the main causes of global biodiversity loss, interactions between invasive species, native biota and recipient environments are poorly known. Their identification may clarify how certain invasive species are able to establish successfully in novel environments and which potential impacts threaten native biota. Nevertheless, both biotic interactions and impacts are usually difficult to detect, especially in early stages of invasion, due to their unexpectedness and the need of long-term studies. Parrots (Order Psittaciformes) are one of the groups most affected by international wildlife trade, consequently, 16% of parrot species show populations out of their native range. Yet, their biotic interactions and impacts are mostly unknown. In this PhD thesis, we combine different data sets (i.e., behavioral, spatial distribution, environmental, and population) to assess the role of different biotic interactions between non-native parrot species, recipient environments and biota and their impacts. In Section 1, we addressed the negative and positive interactions between Rose-ringed Parakeets

Psittacula krameri, Monk Parakeets *Myiopsitta monachus* and recipient cavity nester communities to derive impacts on native fauna. On one hand, we tested potential competition for nesting sites (tree cavities) between Rose-ringed Parakeets and the native cavity nester community established in Seville, through analyses of spatial nest distribution and interspecific aggressions. We found that Rose-ringed Parakeet aggressively out-competed several native species, which affected their nest distributions, even producing the decrease of a Greater Noctule population *Nyctalus lasiopterus*. On the other hand, we monitored several Monk Parakeet populations in native and invaded areas to assess if they may be facilitating nest-sites to coexisting cavity nesters. Our results supported that Monk Parakeet is an ecosystem engineer that provided nest-sites, especially in rural and invaded areas. Moreover, interspecific colonies of Monk Parakeets and their tenants developed cooperative defense against predators. Thus, both native species and invasive tenants were benefited, so the latter may be not only assisted in their invasion processes, but also increase the magnitude of their impacts. In Section 2, we explained how novel behaviors may overcome limitations imposed by new environments, allowing thus the settlement of non-native parrots. First, we addressed whether a novel nesting association between invasive Monk Parakeets and native White Storks *Ciconia ciconia* may overcome biotic resistance of native predators during the spread of invaders into rural areas from Madrid. We analyzed the nest distribution of Monk Parakeets, storks and raptors both in rural and urban environments, as well as differences between Monk Parakeets with and without associated storks regarding their behavioral responses to predators and nesting abandonment rates. Results indicated that nesting associations were more likely in rural areas with high densities of conspecific nest and low densities of raptor nests. Moreover,

Monk Parakeets were strongly dependent on their associated storks to avoid predation pressure, so native species can play the role of facilitators or controllers in biological invasions. Second, we approached how constraints in nest-site availability may be overcome through behavioral innovations that spread across a Rose-ringed Parakeet population established in Tenerife, inducing positive population effects. We annually recorded a growing number of pairs that excavated their own nest cavities and used Monk Parakeet nests, in parallel with a reduction of available natural cavities. Thus, these innovative pairs not only obtained better nests, but also boosted population growth and the invasion process of the species. Third, we highlighted how hybridization among non-close relatives may help to overcome mate shortage and other Allee effects, studying an Orange-winged Amazon *Amazona amazonica* population from Tenerife during its first stages of establishment. We recorded that a male Orange-winged Amazon and a female Scaly-headed Parrot *Pionus maximiliani* successfully bred healthy hybrid offspring across five years, allowing the population growth of this incipient population. In Section 3, we focused on animal-plant mutualisms to understand the effects of parrot introductions on native flora across different taxa, countries, and environments. On one side, we assessed the role of non-native parrots as promoters of secondary seed dispersal through food-wasting. We showed that this feeding behavior is widespread among parrots. Non-native plants were the most dispersed ones, and a large number of species secondarily dispersed seeds after their facilitation by parrots. On the other side, we studied the overlooked epizoochory in parrots and our results indicated that it is a mechanism generalized in fruits with viscid pulp and seeds with anemochory structures. Besides, non-native plants were mainly dispersed by non-native parrots, so mutualistic interactions between non-natives may trigger

invasional meltdown processes. Finally, in Section 4, we assessed the feasibility and efficiency of different management actions to deal with an invasive Rose-ringed Parakeet population established in Seville. We used population viability analysis and demographic data to simulate the output of different scenarios where reproductive and survival rates were reduced. Our results supported actions focused on removing individuals, mainly shooting, which were the most feasible methods in detriment of methods focused on breeding failure, since the Rose-ringed Parakeet population would rapidly recover if management actions were inefficient. Overall, this PhD thesis shows how non-native parrot species can develop a wide range of biotic interactions that may threaten or benefit several coexisting species, both native and non-native. Our wide analyses and long-term studies support that biotic interactions are key for successful establishment and invasion process in non-native parrots. Moreover, ecological impacts are a risk for native biota, especially for threatened species; hence, it is imperative the conservation of the biodiversity through efficient management plans.

Academic year: 2019-2020.

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[The role of ecology in the evolution of coloration in owls.](#)

[El papel de la ecología en la evolución de la coloración en los búhos.]

Key words: activity rhythm, colour patterns, comparative phylogenetic analyses, evolutionary ecology, multi-scale approach, owls.

Palabras clave: análisis a diferentes escalas, análisis filogenéticos comparativos, búhos, ecología evolutiva, patrones de color, ritmo de actividad.

Abstract:

Birds show an extraordinary variability in colour patterns shaped by natural and sexual selection to fulfil several functions like communication, camouflage and/or protection. The factors promoting colour variation can be diverse and act differently on different traits and levels of organization, from individuals within a population to different species inhabiting large geographical scales. Therefore, to understand holistically how ecology influences the evolution of colour diversity, it is necessary to consider multiple levels of study, including different traits but also different species encompassing a wide range of ecological conditions. This thesis adopted such a multiple-scale approach combining: i) ecogeographical analyses at a world scale, ii) comparative phylogenetic analyses to control for the possible effects of common ancestry, and iii) field data of two species collected in a single population, to assess the relative importance of various ecological and evolutionary factors in determining colour variation in owls. Specifically, we aimed to investigate: i) melanin-based colour patterns in relation to broad-scale latitudinal gradients in the frame of classic ecogeographical rules; ii) the key ecological drivers promoting interspecific variability in colour polymorphism; iii) the evolution of interspecific iris colour variation in relation to activity rhythm; and iv) the potential function of iris coloration as a quality indicator in different communication contexts in two owl species with different ecology. Ecogeographical analyses revealed that owls display darker phenotypes near the equator. In particular, owls inhabiting warmer regions and living in more densely vegetated areas were darker. Analyses on a pigment basis showed

that darker colorations associated to higher tree cover were more likely eumelanic, which would agree with a possible role of eumelanin-based patterns in camouflage. On the other hand, the proportion of colours potentially due to pheomelanin (i.e. more fulvous colorations) increased in warmer and rainier areas. These findings are consistent with Gloger's rule main expectation of darker colorations in warmer and wetter areas and stress that climatic and environmental factors have simultaneously contributed to shape large-scale plumage colour variation within the clade. In a second step, we examined the relative importance of several ecological drivers in promoting the evolution of colour polymorphism in owls in the frame of three non-mutually exclusive evolutionary scenarios: the apostatic selection hypothesis, the niche divergence hypothesis and the neutral selection hypothesis. In agreement with the niche divergence hypothesis, species living under more variable luminal conditions, i.e., species with diurnal and crepuscular habits and those inhabiting in a mixture of open and closed habitats, were more likely found to show colour polymorphism. Correlated evolution analyses revealed that a change in the luminal niche might be a fundamental requisite for the evolution of colour polymorphism. Moreover, owl species occupying lower trophic levels were more frequently polymorphic, which could reveal a particularly high selection for crypsis on small species. Results, thus, suggest that colour polymorphism in owls is an adaptive character likely maintained by a selective advantage of morphs under different environmental conditions via disruptive selection mechanisms. Afterwards, we used phylogenetic comparative models to test the camouflage hypothesis for eye colour, a conspicuous feature whose functional basis remains poorly understood. Ancestral state reconstruction revealed that the ancestor of the family Strigidae was more likely bright-irided whereas the ancestor of

the family Tytonidae was more likely dark-irided, possibly reflecting the different evolutionary histories of the two families. In addition, we found that the proportion of dark-eyed species was higher among strictly nocturnal owls than among diurnal ones, suggesting that iris coloration and nocturnality coevolved and that a shift to a nocturnal niche may have led to the evolution of dark eyes in owls. However, the specific evolutionary pathway by which iris colouration and activity rhythm coevolved remains to be investigated as the concealment function from undesired visual receptors was only partially supported. Finally, we studied whether variation in iris yellowness may potentially play a signalling function and serve as an indicator of quality in parent-offspring communication and other social contexts in Little Owl *Athene noctua* and Scops Owl *Otus scops*. Yellowness did not differ between sexes; however, adults of the two species had more intensely yellow irises than owlets. In owlets, most of iris variation occurred between rather than within nests and was seemingly linked to parental qualities in Little Owls, but was unrelated with condition among Scops Owl owlets. In adults, nevertheless, iris yellowness of females was positively associated with nest success (an index of female fitness) in Little Owl, but not in Scops Owl. Our findings discard a role of iris colour variation in parent-offspring communication in these two owl species, but iris yellowness may potentially play a signalling role in social contexts at least in Little Owl. This species has a broader activity rhythm compared to the crepuscular habits of Scops Owl. This, together with the higher territoriality of Little Owls, may indicate a greater importance of visual communication based on chromatic signals potentially involving iris colour in displays between conspecifics. To summarise, this thesis provided strong support for the idea that detectability in different light conditions, determined by differences

in both activity rhythm and vegetation cover, may be a key driver of inter- and intraspecific colour variation in different traits in owls at different spatial scales. Finally, this research gave a first glimpse at the role of iris colour in communication in different social contexts in owls although experimental work is needed to pinpoint the exact mechanisms behind the relationship here observed.

Academic year: 2019-2020.

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[Ecology and habitat selection by Turtle Dove \(*Streptopelia turtur*\) and Collared Dove \(*Streptopelia decaocto*\) in eastern Spain.](#)

[*Ecología y selección de hábitat de la tórtola común (Streptopelia turtur Linnaeus, 1758) y de la tórtola turca (Streptopelia decaocto Frivaldszky, 1838) en el este de España.*]

Key words: distance sampling, distribution expansion, Hierarchical partitioning analysis, Mediterranean, population decline.

Palabras clave: análisis de partición jerárquica, disminución de la población, expansión de la distribución, Mediterráneo, muestreo por distancia.

Abstract:

Organisms select habitat and respond to landscape structure at different scales. How birds perceive the area and objects in the landscape is thought to determine their use of a given habitat. This in turn is governed by their own natural history: feeding and nesting needs, body size, and community relationships. In this thesis I investigate the ecology and habitat selection of a declining species, the Turtle Dove *Streptopelia turtur* and its congener, the Collared Dove *Streptopelia decaocto*, whose populations and distribution are expanding. The specific objectives are focused on: i) to evaluate the population trend of the Turtle Dove during a 45-year period (1975-2019) in orange groves of eastern Spain; ii) to model the distribution of the Turtle Dove in the southeast of the Iberian Peninsula to identify the variables that best explain its range from samples collected when the species was not in decline, iii) to determine the factors favoring the expansion of the Collared Dove and microhabitat preferences in humanized areas, iv) to model the habitat occupied by the Turtle Dove in semi-arid environments in southeastern Spain, and v) to estimate the abundance of the Collared Dove in urban environments in eastern Spain. All data on the occurrence of both species obtained during censuses for the Breeding Birds of the Alicante Province were used to model the macrohabitat selection. A total of 113 predictive variables were taken in groups referring to: habitats and land use, topography, hydrographic network, canals and ponds, urbanizations, roads, and climate. I used point counts to estimate abundance and model Collared Dove microhabitat in the provinces of Valencia and Alicante. Mapping methods and nest searching techniques have been applied to evaluate the population trend of the Turtle Dove. The number of Turtle Dove breeding pairs per season influences fledglings' production and breeding success, so that both variables tend to be higher in those years when the abundance of breeding pairs is higher. The mixture of pines and scrubland in the semiarid areas and the length of unpaved roads were the most important variables with a positive effect on occurrence of Turtle Doves, while the Collared Dove is positively associated with the presence of water bodies, length of paved and unpaved roads, area occupied by isolated houses and agricultural tree plantations (mainly almond and citrus trees). Our results show that the

topelia decaocto, whose populations and distribution are expanding. The specific objectives are focused on: i) to evaluate the population trend of the Turtle Dove during a 45-year period (1975-2019) in orange groves of eastern Spain; ii) to model the distribution of the Turtle Dove in the southeast of the Iberian Peninsula to identify the variables that best explain its range from samples collected when the species was not in decline, iii) to determine the factors favoring the expansion of the Collared Dove and microhabitat preferences in humanized areas, iv) to model the habitat occupied by the Turtle Dove in semi-arid environments in southeastern Spain, and v) to estimate the abundance of the Collared Dove in urban environments in eastern Spain. All data on the occurrence of both species obtained during censuses for the Breeding Birds of the Alicante Province were used to model the macrohabitat selection. A total of 113 predictive variables were taken in groups referring to: habitats and land use, topography, hydrographic network, canals and ponds, urbanizations, roads, and climate. I used point counts to estimate abundance and model Collared Dove microhabitat in the provinces of Valencia and Alicante. Mapping methods and nest searching techniques have been applied to evaluate the population trend of the Turtle Dove. The number of Turtle Dove breeding pairs per season influences fledglings' production and breeding success, so that both variables tend to be higher in those years when the abundance of breeding pairs is higher. The mixture of pines and scrubland in the semiarid areas and the length of unpaved roads were the most important variables with a positive effect on occurrence of Turtle Doves, while the Collared Dove is positively associated with the presence of water bodies, length of paved and unpaved roads, area occupied by isolated houses and agricultural tree plantations (mainly almond and citrus trees). Our results show that the

density of groups and individuals of Collared Dove is lower in urban areas compared to parks and peri-urban areas. The expansion of urbanization towards inland areas would have a detrimental effect on the Turtle Dove, especially if such expansion occurs close to pine forests. On the other hand, this expansion creates local conditions that favor the establishment of the Collared Dove.

Academic year: 2020-2021.

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Incubation behaviour of Great Tits *Parus major* in response to ambient temperature in three contrasting Mediterranean habitats.

[Comportamiento de incubación del carbonero común Parus major en respuesta a la temperatura ambiental en tres hábitats mediterráneos distintos.]

Key words: egg repositioning, Great Tits, hatching asynchrony, incubation rhythms, nest attentiveness.

Palabras clave: atención al nido, carbonero común, eclosión asíncrona, reposicionamiento de los huevos, ritmos de incubación.

Abstract:

Avian incubation is a complex behaviour that, in female-only incubator species, entails key trade-offs between egg warming periods and time off the nest for female self-maintenance. The dynamics between on- and off-bouts are thought to be mainly influenced by ambient temperature, because changes in egg cooling rates would determine how females allocate their time during incubation. Incubating females need to avoid deviations from the optimal embryo development temperature. Low ambient temperature limits female's time off the nest but also incubating time (higher energy expenditure). On the other side both on- and off-bouts are ex-

pected to lengthen when temperatures increase because incubation constraints are eased. Females usually lengthen on-bouts at a higher rate, thus increasing incubation effort. The opposite response, i.e., increasing self-maintenance time with increasing ambient temperature, has been also reported in several species or just in certain populations of a species. While these opposite behavioural responses might be the result of different breeding strategies adapted to habitat conditions, it might also be the consequences of limited datasets, different methodological approaches, or the timescale at which incubation behaviour is measured. Determining the onset of incubation also implies certain complexities derived from trying to delimit a progressive behaviour that is gradually settled during the egg-laying period. Despite classic studies in passerines describing both diurnal and nocturnal incubation and their respective periods of partial and full incubation, little is known about how the onset of incubation relates to ambient temperature and its effects on hatching asynchrony. Ambient temperature might have a major role in the onset of incubation if females use it as a cue to synchronize their hatching date with the expected peak of prey abundance. Prey development, e.g., caterpillars, accelerates with increasing temperatures. Once females start laying eggs, they could only keep track of faster prey development by an earlier onset of incubation, but the latter implies incubating before the clutch is complete, potentially causing hatching asynchrony. Hatching asynchrony could still occur even if incubation is delayed after clutch completion. Thermal gradients within the clutch during incubation might be a potential factor behind this residual hatching asynchrony. Females keep eggs under their brood patch warmer than peripheral ones, unable to cover the whole clutch. If females do not distribute the heat by repositioning eggs within the nest-cup it could cause a differential embryo

development, potentially resulting in hatching asynchrony. In this thesis I have collected high-quality incubation data of the Great Tit *Parus major* during three consecutive years in three different breeding populations. The main aim of the project was a better understanding of the dynamics of incubation behaviour, its onset, and the consequences on hatching asynchrony in relation to ambient temperature. During an additional fourth breeding season, I investigated whether differential egg repositioning within the clutch, a rarely studied behaviour, influenced hatching asynchrony. Incubation behaviour was recorded using temperature data loggers placed in the nest-cup and egg repositioning was calculated from photographed clutches during the incubation period. First, I delimited the different incubation behaviours (diurnal and nocturnal, partial and full), quantified them, and assessed how ambient temperature affected their onset relative to the egg-laying sequence. I also assessed the association between the onset and duration of these incubation behaviours and the extent of hatching asynchrony. Secondly, I tried to comprehend incubation rhythms (i.e., the relation between on- and off- bouts during diurnal full incubation) in relation to ambient temperature. I aimed to investigate whether divergent patterns of nest attentiveness were a result of different breeding strategies or data artefacts. Finally, I experimentally prevented partial incubation of clutches and assessed the effect on hatching asynchrony. I also investigated if residual hatching asynchrony could be endorsed to differential egg repositioning within the clutch during the diurnal full incubation period. I found that both ambient temperature and clutch size affected the onset of incubation behaviour.

Increasing ambient temperature during the egg-laying period advanced diurnal partial incubation relative to the laying sequence, but larger clutches delayed the onset of both nocturnal full incubation and diurnal partial incubation. Only diurnal incubation affected hatching asynchrony despite nocturnal periods being longer. Both partial incubation and full incubation occurring before clutch completion increased hatching asynchrony. I also showed that incubating females allocated time into self-maintenance at higher ambient temperatures (i.e., reducing nest attentiveness when constraints alleviate), as a generalized response among populations. Females maximised incubation bouts duration based on local temperatures and not on absolute values as suggested in previous studies. This behaviour translated into different nest attentiveness patterns depending on the timescale, even showing contrary incubating behaviours. Experimental clutches where partial incubation was prevented showed longer incubation periods and reduced hatching asynchrony. However, egg repositioning within the clutch did not seem to be the cause of the observed residual hatching asynchrony. In conclusion, ambient temperature is a key variable for incubation behaviour, both for its onset and rhythms. It affects the onset of incubation asymmetrically, advancing only diurnal partial incubation. Female incubation rhythms differ among populations because they maximise on- bout duration at different local ambient temperatures. Ambient temperature, both during the egg-laying and full incubation period, is indirectly associated with the duration of the full incubation period and the extent of hatching asynchrony.

Academic year: 2020-2021.