Phd-Dissertation Reviews in Ornithology (2016–2017 Academic Year)

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PHD-DISSERTATION REVIEWS IN ORNITHOLOGY (2016-2017 academic year)

Edited by Francisco VALERA

This section includes the abstracts of some of the PhD-Dissertations submitted in Spain during the 2016-2017 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 2016-2017 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 (ardeola@seo.org). The Scientific Committee of SEO/BirdLife grants a biannual 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 (ardeola@seo.org). El Comité Científico de SEO/BirdLife otorga con carácter bianual 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 Autónoma de Madrid

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Physiological adaptations in the Pied Flycatcher (*Ficedula hypoleuca*): oxidative stress, reproduction and development.

*[Adaptaciones fisiológicas en el papamoscas cerrojillo (*Ficedula hypoleuca*): estrés oxidativo, reproducción y desarrollo.]*

Abstract:

Oxidative stress is the imbalance between the antioxidant capacity of an organism and the production of free radicals that can damage important biomolecules (lipids, proteins or DNA), affecting cellular senescence. Environmental conditions experienced by organisms can exert a strong influence on the development and expression of their phenotype, especially during early development and reproduction, which may determine access to territories, fecundity and survival. On the other hand, understanding the relationship between oxidative status and telomere dynamics –regions of non-coding DNA whose function is to stabilize the structure of chromosomes and with a fundamental role in ageing– is essential to fully appraise the mechanisms underlying the life-histories determined by the existing trade-offs between reproduction, maintenance and growth. Thus, the main objective of this thesis is to determine, from an ecological-evolutionary point of view, the role of oxidative stress in relation to the different life-histories developed by the birds, analyzing the influence of the nesting environment and the intrinsic and external factors affecting individuals during early development and reproduction. We have studied the physiological adaptations, in relation to oxidative stress, to the different trade-offs that birds face during their life cycle. The Pied Flycatcher (*Ficedula hypoleuca*) has been used as the study model. The study areas are located in the Sierra de Guadarrama, one in Montes de Valsaín (Segovia), where there are 570 nest boxes, and another one in Lozoya (Madrid), with 100 nest boxes. Both experimental and observational studies have been carried out to analyze the influence of nesting environment and nest-dwelling ectoparasites on nestlings and parental individuals, the costs derived from the reproductive investment and the maintenance of sexual ornaments, the factors affecting the redox status in the early life and the relationships between reproduction, oxidative stress and ageing. Films of nests have been made to analyze parental care and, in all cases, blood samples have been taken from all individuals (adults and nestlings), for analysis of oxidative and biochemical parameters (oxidative damage, antioxidants, triglycerides, uric acid), sex (only in nestlings) and measures of telomeres (adults). In addition, photographs of adult plumage ornaments have been taken to analyze them as a sign of individual quality. This thesis contributes to verify the strong implication of the oxidative state in the trade-offs that sustain life-histories of birds. On the one hand, this thesis shows that the presence of old material in the nest does not affect all populations of ectoparasites equally, questioning the general idea that nest reuse is linked to higher infestations, with consequences on reproductive success and nestling growth. In addition, it is shown how the method to reduce ectoparasite loads of the nest can have uncontrolled effects on birds, which may lead to underestimation of the potential consequences of the presence of such ectoparasites on their avian hosts. We found experimental evidences of negative effects of ectoparasite loads on the oxidative status of adult females and developing chicks, which could have consequences on future survival and reproduction. This study also shows the associations between different components of the oxidative status of developing

chicks and various environmental and intrinsic factors, which is essential to understand the importance of oxidative stress in the formation of the phenotype. On the other hand, it is suggested that different achromatic features of plumage can signal the individual capacity to cope with oxidative stress and the importance of the different phases of the reproductive cycle is emphasized to understand the role of oxidative stress as cost and constraint in reproduction. Finally, it is evidenced how the oxidative status is related with telomeres shortening (consequently with a greater cellular ageing) of the individuals in adulthood as a cost of reproduction, in addition to suggesting that the physiological age of the parents can affect the quality of the offspring in terms of oxidative stress. This framework of relationships shows that the ecology of organisms is partly oxidative ecology. In short, this thesis opens new avenues for future studies on life-histories, behaviour and ecophysiology in natural populations, suggesting that these will benefit from including different oxidative parameters of individuals.

Academic year: 2016-2017.

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Environmental influence on the expression and selection of melanin-based traits in the Common Kestrel (*Falco tinnunculus*).
*[Influencias ambientales en la expresión y selección de caracteres melánicos en el cernícalo vulgar (*Falco tinnunculus*).]*

Abstract:

The animal kingdom is a constant source of conspicuous structures and behaviours that have drawn the attention of the scientific community. These traits play a crucial role in the life of animals, since they are the pillars where communication systems lay on and help individuals to resolve many conflicts. Animal communication can occur by very different means, but always in a bidirectional fashion that involves a sender modulating the behaviour of the receiver. An essential requirement to obtain stable communication systems is that the signals have to be a reliable proxy of individual condition. The honesty of animal signalling relies on the differential cost of production or maintenance paid by low- and high-quality individuals. From an evolutionary perspective, the presence of stable communication systems is indicative that, at least on average, the signals used in them are reliable. If they were not reliable, natural selection is expected to favour individuals that do not react to those dishonest signals and, in the end, the communication system will vanish, at least from an evolutionary viewpoint. As a matter of fact, not all individuals within a single species exhibit the same traits with equal intensity or form. This heterogeneity in trait expression is determined by different factors, which can be both intrinsic and extrinsic to the bearers. The study of the factors that modulate signal expression is crucial to understand the message that is transmitted, and the evolutionary pressures behind its expression. The use of colour-based traits is one of the most typical ways of signalling, being those based on melanin the most common in the animal kingdom. Melanin is responsible of many colours, commonly associated with black or grey but also responsible for brown and reddish-brown colourations. Melanin-based traits have a crucial role within animal communication. Still, the main role of these traits has been pointed towards a signalling function of the individual status, showing the competitive capabilities of the bearers. In this PhD thesis, I describe different mechanisms and functions associated with the expression of melanin-based traits, using the Common Kestrel (*Falco tinnunculus*) as study species. Kestrels are medium-sized raptors, exhibiting a reversed sexual dimor-

phism, where males are 20% smaller than females. They are also dimorphic in coloration, being males more conspicuous than females. Kestrels have a homogeneous distribution in the Iberian Peninsula, and the study areas of this PhD were located in central Spain. The first population located in Campo Azálvaro region (between Segovia and Ávila), has been subjected to an individual-based monitoring since 1994. Second, Villalar de los Comuneros (Valladolid) was monitored during one of the experiments performed in this thesis with the aim of increasing the number of observations and the environmental heterogeneity. The main objective of the thesis was to study the factors that modulate the expression of different melanin-based traits and their function in different environments. These aspects were developed on their own in five chapters. The first two were focused on exploring how age, environmental conditions and their interaction, modulate the expression of two different melanin-based traits, the spottiness (number and size of spots) of the plumage of adult male and female kestrels', and the percentage of grey colouration in female kestrels' rump. The remaining three chapters explored the function that melanin-based traits have during different stages of kestrels' life-cycles. Specifically, the third chapter experimentally tested the role of female rump colouration as a signal of status within an intra-sexual competition context during the pre-laying period. In the fourth chapter, I explored the role of fledglings' rump coloration, the duration of the post-fledgling dependence period and their interaction on the survival rates of the fledglings. Finally, the fifth chapter aimed investigating the role of plumage and rump coloration as personality indexes in kestrel nestlings. Briefly, the results in the first two chapters evidence that the expression of melanin-based traits can be modulated by age, since both the number of spots in males' plumage and female rump coloration decrease and increase respectively as individuals age. Further, a positive association between vole abundance and the size of male spots is also reported, suggesting that the expression of melanin-based traits is sensitive to environmental heterogeneity. I also found that environmental conditions can modulate the association between the number of spots in males and clutch size. As a general conclusion, the results evidence that melanin-based traits can work in different context. On the one hand, they suggest that the percentage of grey coloration in females' rump works as a signal of status within the communication system of female kestrels. On the other, that there is an association between female nestlings and their personality, where those individuals that exhibit blacker plumages behave in a bolder fashion. Finally, there is no significant association between offspring rump colouration and survival, that was, however, positively associated to the duration of the post-fledgling dependence period. Overall, this PhD thesis suggests that melanin-based traits present different sensitivities to the factors that modulate their expression, and that they have a role in various signalling contexts.

Academic year: 2016-2017.

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Habitat influence on life history and behavioural traits of cavity nesting birds.
[Influencia del hábitat en las historias de vida y el comportamiento de aves que anidan en cavidades.]

Abstract:

Identifying general patterns of habitat selection, behavioural adaptations and life-history traits are central issues in evolutionary ecology. Many organisms have been studied to address these issues, but one of the groups with greater influence on current perspec-

tives is birds. This thesis aims to increase knowledge from an evolutionary perspective of the habitat-related differences of life-history strategies and behavioural syndromes in cavity-nesting birds such as the Blue Tit (*Cyanistes caeruleus*) and the Great Tit (*Parus major*). By means of descriptive studies and field and captivity experiments this PhD thesis aims to explain the mechanisms underlying nest-site selection, diet composition, personality types and individual foraging strategies in contrasting habitat types. The use of nest-boxes to study bird breeding biology and as a management tool is widespread. Different nest-box placements could be differentially chosen by birds; however the influence of certain factors (e.g., nest-box density) in occupation rates or breeding parameters has not been sufficiently covered. We used the Blue Tit as a model species to investigate the influence of nest-box position and breeding pair density on occupation rate and breeding success, controlling for habitat structure. Blue Tits preferentially selected nest-boxes located high on the tree and with fewest neighbours. Laying date was earlier in higher nest-boxes and in those with fewer neighbours and at a greater distance from the nearest. Also, fledgling number was positively related to shrub cover and medium tree height, fledging mass was higher when distance to the nearest neighbour was greater and fledging tarsus was positively related to oak-species abundance. Our results suggest that disentangling the key factors for nest-box placement and distribution is important to adapt nest-box supplementation to species-specific requirements in each habitat. Nestlings diet composition and feeding rates seem to depend on parental effort, habitat type and their interactions. We compared the nestling diet of Blue Tits in two Mediterranean forests (pinewood and oakwood) and its implications in breeding success through recordings within nest-boxes when chicks were 11-days-old. We found that although caterpillars (Order Lepidoptera) constituted the largest proportion of nestlings' diet in both habitats, chicks in pinewood were fed more noctuid and tortricid larvae, showing a more homogeneous diet composition than those in oakwood. In contrast, spiders were more frequently fed to oakwood chicks. We demonstrated that such differences influenced the number of fledglings and their body condition. Habitat-specific selection pressures have been widely recognized but whether selection favours different personality types in different habitats has rarely been evaluated. We aimed to test whether personality-related differences in annual reproductive success differed between two populations of Blue Tits occupying different Mediterranean habitats (oakwood and pinewood). We measured exploration and parental provisioning behaviours, and used a path analytical approach to test whether the interplay between these two behavioural traits affected reproductive success in each of these habitats. We found that Blue Tits breeding in the pinewood were slow-exploring compared to individuals breeding in the oakwood, suggesting the occurrence of personality-related differences in settlement, or phenotypic plasticity in response to habitat differences. Faster explorers were favoured in the pinewood, while there was no selection acting on exploration behaviour in the oak habitat. Our findings emphasize the importance of integrating habitat selection, plasticity, and personality in the study of behavioural evolution. The tendency to innovate and the reactive-proactive personality axis have been linked to foraging behaviour but their role in driving intake rate and food selectivity remains unclear. We conducted standardized assays on wild-captured Great Tits from different habitats to characterize individual variation in exploratory and innovative problem-solving performance, both of which are repeatable and have been linked to foraging behaviour. During trials,

birds whose exploration behaviour had been previously assessed were provided with three different types of food in order to detect any diet preference, and daily energy intake was measured. There was no link between exploration behaviour and the amount of calories ingested; however, bolder great tits consumed a higher proportion of sunflower seeds, while slower individuals preferred peanuts. Problem solving performance showed a significant positive correlation with energy intake for those birds that solved a task consistently. Concerning habitat type, birds from the coniferous patches ate more peanuts, although mealworms eaten were marginally higher in those from the deciduous plots. Our results evidence the relationship between exploration behaviour and foraging performance in captivity and contribute to the idea that birds may follow alternative foraging strategies, but obtaining the same energy intake.

Academic year: 2016-2017.

Universidad de Barcelona

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Effects of perturbations and environmental variability on population dynamics of seabirds.

[Efectos de las perturbaciones y la variabilidad ambiental en la dinámica poblacional de aves marinas.]

Abstract:

The overarching aim of my thesis was to assess the role of environmental variability and specially of perturbations in the population dynamics of social vertebrates. Our results emphasize the need to collect individual, population and metapopulation data at long term and large spatial scales. Such information is crucial to understand how wild animal populations respond to environmental variability and perturbations. We demonstrate that environmental variability and perturbations induce complex responses and lead to covariance processes within demographic traits at different spatio-temporal scales. As expected for long-lived species, perturbations encouraged species to halt breeding investment in order to ensure future survival. However, under strong perturbation regimes, an unknown population resilience threshold is surpassed and foregoing reproduction is insufficient to buffer population changes. Cumulative effects of perturbations magnified population decreases across large spatio-temporal scales. Consecutive perturbations are potentially useful tools to effectively manage overabundant species. However, caution must be taken because their long-term consequences are still poorly understood. Severe environmental conditions caused both lethal and non-lethal responses on populations. Non-lethal responses include changes in foraging behaviour, development cultural innovations such as non-random dispersal movements or colonization of novel environments. Individuals responded differentially to environmental variability and consecutive perturbations depending on their individual quality, age, experience and cohort of birth. Such differential responses resulted in severe selection filters and represent a structuring force potentially destabilizing population dynamics. Processes underlying the strong early-life selection pressures on early life survival are not limited to the rearing period, first winter is also critical. Consecutive cohort effects driven by density dependence and climate influence early-life survival of long-lived species, but that influence faded at older ages. Experienced individuals act as an information repository. They are more likely to engage large distance dispersal and colonize new environments. Populations that include older individuals are more likely to be able to effectively and

rapidly adapt to environmental change, at least in long-lived, social species that exhibit social learning. Colonisations are temporally and spatially unpredictable and respond to an accumulation of perturbations exceeding an unknown threshold for colonising new patches. The temporal mismatch between perturbations and colonisations events suggests that colonisers need a longer prospecting period to compensate for the lack of public information. Non-lethal, density independent perturbations, such as predators' presence, can drive changes in populations age structure and, therefore in the population reproductive value, through selection for young and inexperienced individuals with lower breeding success. We provide strong evidences showing that consecutive perturbations, non-lethal effects and non-random individuals' responses across different life stages are more important than previously thought. These results are especially relevant for understanding how populations will respond to the predicted increases in magnitude and frequency of perturbations as a consequence of global change.

Academic year: 2016-2017.

Universidad Complutense de Madrid

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Indicators of individual quality in the Blue Tit (*Cyanistes caeruleus*): parasitism, colour, paternity and ageing.

*[Indicadores de calidad en el herrerillo común (*Cyanistes caeruleus*): parasitismo, color, paternidad y envejecimiento.]*

Abstract:

The study of individual quality is paramount in evolutionary ecology if one is to unravel life-history trade-offs. The investment in self-maintenance, reproduction or survival may be determined by an individual's quality. Moreover, obtaining information from conspecifics might be essential in mate choice because mating with higher quality individuals could ensure direct or indirect benefits for the offspring. Several studies have provided conclusive evidence that individuals can assess variation in the quality of conspecifics through several indicators of quality. In birds, plumage ornamentation has received much attention in the literature as an indicator of quality, and it is well known that females often prefer more conspicuously ornamented males. Multiple ornaments may convey different pieces of information regarding quality, but no consistent pattern has emerged to this respect. Other indicators of quality may refer to physiological parameters that convey information about health status (for example, blood parasitic infections), or ageing processes (measured through telomere shortening as a biomarker for ageing). On this basis, the overall aim of this thesis is to further increase the knowledge on indicators of individual quality in birds, using the Blue Tit (*Cyanistes caeruleus*) as model species. Data for correlational and experimental studies were collected in a Blue Tit population breeding in nest-boxes in central Spain (Valsaín, Segovia) during the 2012-2014 breeding seasons. Throughout several chapters in this thesis, we explored how infections by several parasite species, plumage colouration in multiple ornaments, mating strategies or ageing may relate to individual quality in adult and developing Blue Tits. Using models based on avian colour vision we found that structural colouration in several ornaments may depend on stress during reproduction or development. During reproduction, intense parasitic infections by avian malaria-like parasites had a differential effect on the quality of the white cheek feathers developed during the post-reproductive moult.

Similarly, nestling Blue Tits that suffered from parasitic infections at the nest developed more saturated green tails and duller blue crowns after the post-juvenile moult. Moreover, we offer correlational evidence for assortative mating in the Blue Tit. Lower quality males paired with females that laid more pigmented eggs, but previous studies indicated that these females were in poor condition. Thus, male quality may be determinant in eggshell pigmentation, because poor quality male Blue Tits may provide less food to laying females during courtship, or, alternatively, the pair may breed in poor territories with less access to nutrients for females. Additionally, these males were younger and more likely to father extra-pair offspring, probably as a result of mating with poor quality females. In a different breeding season, we showed that older and higher quality males were more ornamented and sired more extra-pair offspring, while bearing the risks of being infected with more blood parasites as a result of engaging in extra-pair copulations. Finally, our results suggest that the costs of reproduction may be mitigated in individuals in better nutritional status. After experimentally supplementing adult Blue Tits with antioxidants during the costly reproductive event, we observed reduced telomere shortening one year after. To sum up, our findings support the idea that immunologically naïve individuals may suffer the costs from parasitic infections in the shape of reduced colour expression in structural ornaments, reduced paternity and accelerated ageing; but high quality individuals may overcome these costs while investing in ornamentation and maximizing reproductive success. Thus, this thesis confirms that the implication of parasitic infections, structural colouration, mating strategies and nutritional status on reproductive performance, self-maintenance and senescence should not be overlooked.

Academic year: 2016-2017.

Universidad de Córdoba

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Generating key scientific information for the conservation-oriented management of Magellanic Woodpecker (*Campephilus magellanicus* King 1828), in Nahuelbuta Coastal Range, Araucanía Region, Chile.

*[Generación de antecedentes científicos clave para un manejo forestal orientado a la conservación del carpintero negro (*Campephilus magellanicus*) en la Cordillera de Nahuelbuta, Región de La Araucanía, Chile.]*

Abstract:

This study was carried out in the only temperate rainforest in the ecoregion of South America, which is also the second larger continuum forest of that kind at global level. The study area is located in a section of the Nahuelbuta coastal range (37º43'S 73º02'W) which has been subjected to strong processes of ecological fragmentation and ecological impoverishment. The subject of study was the Magellanic Woodpecker (*Campephilus magellanicus*), a key bird species of these forests, whose geographic distribution ranges from central Chile (34°05'S 70°54'W) to extreme southern Chile (54°56'S 68°40'W), covering also surrounding areas in the Republic of Argentina. First, a synthesis on the current knowledge of *C. magellanicus* was prepared with regard to life-story, ecology of reproduction, behaviour and habitat requirements at different scales. The specialized use that *C. magellanicus* does of its environment allowed us to prepare an analytic and objective characterization of its feeding habitat in the forest ecosystems of the Nahuelbuta National Park. Additionally, the population attributes of the avifaunistic assembly, from which *C. magellanicus* is part, were characterized. Results indicate the existence of certain structural attributes of the vegetation

that are correlated directly with the feeding habitat of *C. magellanicus*, as it is the cover of dominant trees, herbaceous cover and the state of decomposition of standing trees. We used the Model of Maximum Entropy (Maxent) and a Geographical Information System (QGis) in order to propose a model for describing the potential habitat of *C. magellanicus* in the Nahuelbuta Coastal Range (514,409 has.). Thus, a series of attributes that define the preferred habitat of *C. magellanicus* in this type of landscape was objectively identified. It is concluded that the preferred habitat of the species corresponds to fragments of temperate native rainforests from medium to large size, dominated by Coigue Birch (*Nothofagus dombeyi*) and/or Monkey Puzzle Tree (*Araucaria araucana*). These are located far from forestry plantations of exotic species and present minimum temperatures during the coldest months. Also, a map of the potential distribution of *C. magellanicus* in the Nahuelbuta Coastal Range was generated, in which most of the important areas for the conservation of this species are identified. Concerning the property regime, most of the study area was government owned (National Park) or managed by the government, and therefore, there was a good level of protection. The conservation of the species in the remaining area varies according to the property regime and property size. In properties owned by big forestry companies, their own management and conservation policies allowed an adequate level of protection for the species. However, less secure situations were expected in terms of conservation in territories owned by small and medium-sized companies where it was not possible to ensure minimum conservation measures for the fauna associated with these native forests. This is due to the inexistence of a forestry legislation specific for protecting *C. magellanicus*. We observed and report a couple of adult *C. magellanicus* individuals preying on tebo worms (*Chilecomadia moorei,* Cossidae: Lepidoptera) in an apple orchard (*Malus domestica*), demonstrating the high level of phenotypic plasticity of this species. This finding advices future research oriented to the design of new management strategies for the conservation of *C. magellanicus*. Results from this research add key scientific knowledge for forestry management oriented to the conservation of *C. magellanicus*, within landscapes and ecosystems of the temperate native rainforests of Nahuelbuta Coastal Range, Chile.

Academic year: 2016-2017.

Universidad de Granada

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Ecological interactions mediated by the European mistletoe, *Viscum album* subsp. *austriacum*, in Mediterranean forests –an integrated perspective.

[Interacciones ecológicas mediadas por el muérdago europeo, Viscum album *subsp.* austriacum*, en bosques mediterráneos –una perspectiva integrada.]*

Abstract:

In this thesis, we seek a deeper and broader understanding of the ecological interactions mediated by the mistletoe *Viscum album* subsp. *austriacum* in Mediterranean forests. Mistletoes constitute an interesting group of hemiparasitic epiphytes widely distributed around the world that have been thoroughly investigated with respect to their physiology, morphology, pharmacology and their role as forest pest. However, many aspects of their ecology remain a mystery. Better known as harmful parasites that decrease the vigor of their host trees, today we have little knowledge about the ecological interactions mediated by these parasites, as well as their direct and indirect effects on natural

communities and ecosystems. In this thesis, we show that, although being a minor component of the forest community (in terms of abundance and biomass), mistletoe can play a relevant role in the forest. Spread over five chapters we study the close relationship of mistletoe with its host trees and seed dispersers, as well as the effect of the parasite on different organisms of the natural community and ecosystem properties. In Chapter I, we focus on the mistletoe-host interaction. We analyze different factors shaping the spatial distribution of mistletoe in the forest canopy, including host specificity and the variation of biotic and abiotic factors limiting safe sites for mistletoe recruitment. We found that mistletoe shows a strong host specificity for pine species, in particular for *Pinus nigra* (the most abundant species) at the local scale. We also found that biotic and abiotic factors exert a non-random filter on mistletoe regeneration, resulting in recruitment hotspots at the periphery of tree branches. In Chapter II, we focus on the mistletoe-vector interaction. We study the seed dispersal effectiveness of an unspecialized group of frugivorous birds providing dispersal services to a parasitic plant with extremely narrow ranges of safe sites to recruit. Our results indicate that a wide and heterogeneous assemblage of generalist birds successfully disperse mistletoe seeds by two different mechanisms: endozoochory and ectozoochory. Large generalist birds (thrushes) constitute the most effective dispersal group; however, they provide low-efficiency services, consuming numerous fruits to successfully disperse a single seed. In contrast, small generalist birds provide better quality and more efficient dispersal, but of low-quantity. Finally, opportunistic birds are very efficient dispersers by moving seeds externally and directly to safe sites of the tree periphery. By having a wide and heterogeneous range of seed dispersers mistletoe ensures the maintenance of re-infection processes within the population and the colonization of new infection foci. In Chapter III, we examine interactions between mistletoe and fleshy-fruited plants of the understory. We analyze the effect of mistletoe spatial heterogeneity on the seed-deposition pattern of the zoochorous plant community. We observed that frugivorous birds respond to mistletoe patchiness by visiting parasitized trees preferentially to unparasitized ones, generating a differential deposition of mistletoe seeds on tree branches, increasing re-infection processes within the host, while dispersing seeds of co-fruiting species under the host canopy. Moreover, as mistletoe fruit-crops vary little from one year to the next, there is a temporal persistency of seed deposition sites, with the canopy of parasitized trees consistently receiving large mistletoe seed rain. Otherwise, understory species show strong fruit-crop fluctuations between different years, which is reflected in the abundance of seeds reaching microsites beneath the host each year. In Chapter IV, we explore mistletoe-mediated aboveground-belowground interactions. We analyze the effect of mistletoe and the parasitic and mutualistic interactions it mediates from the forest canopy on soil-chemical and biological properties. We found that mistletoe modifies the linkages between the forest canopy and the soil through time, increasing the amount, quality and diversity of organic matter inputs beneath the host canopy, directly through its nutrient-rich litter and indirectly through the decrease of host litter fall and the increase of bird-derived debris. This greater abundance and diversity of organic compounds gives rise to enriched hotspots able to support greater and more functionally diverse soil microbial communities beneath parasitized hosts, the effects of which are accentuated after host death. In Chapter V, we study the effect of mistletoe on the structure and dynamics of the plant community. We seek to understand whether mistletoe-induced changes under host patches, coupled to the effect of post-dis-

persal processes, ultimately result in changes in the plant community assemblage. We found that mistletoe induces significant changes on host growth through its parasitic interaction, leading to greater light infiltration to the forest floor. At the same time, mistletoe facilitates seed arrival of understory species on the fertilization islands generated beneath the host, where conditions for seedling establishment improve. Consequently, parasitized trees concentrate a more abundant and richer fleshy-fruited plant assemblage than non-parasitized trees, and, in turn, enhance plant growth. Moreover, by coupling detrimental effects on their hosts and facilitative effects on the woody-plant community over long time periods, mistletoe affects patch dynamics and community succession, promoting the replacement of a dominant host tree (*Pinus nigra*) by a diverse community of subdominant zoochorous plants. In conclusion, by taking a broader view of mistletoe and considering a wider breadth of its biotic interactions, we found several direct and indirect facilitative effects of the parasite on different organisms in the community. Thus, far from being a harmful organism, our findings show that mistletoe can play an important role in regulating the spatial-temporal dynamic of the forest ecosystem, enhancing the structural and biological complexity of the forest it inhabits.

Academic year: 2015-2016.

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Feathers, plants and bacteria in Spotless Starling (*Sturnus unicolor*) nests and their effects on reproduction.

*[Plumas, plantas y bacterias en nidos de estornino negro (*Sturnus unicolor*) y sus efectos en la reproducción.]*

Abstract:

Selective pressures imposed to birds by pathogenic microorganisms are very strong during the nesting period, so birds have evolved numerous defensive strategies to counteract their effects. One of these strategies is the use of nest materials with antimicrobial properties, like aromatic green plants. The antimicrobial characteristics come from their secondary metabolites, which can reduce the negative effects of nest microorganisms. In addition, the presence of aromatic plants is positively related with nestlings' growth and their immune system. Most of these studies have been conducted on Blue Tit (*Cyanistes caeruleus*) and Common Starling (*Sturnus vulgaris*) nestlings, but little is known about the effect of aromatic plants on egg bacterial load and in other avian species. Feathers are another common nest lining material employed by birds. Feathers can also act as antimicrobial material due to the compounds produced by bacteria that grow in feathers, called keratinolytic bacteria. These bacteria segregate antimicrobial compounds, which birds can use to reduce the bacterial load in their nests. In addition, keratinolytic bacteria can degrade unpigmented feathers better that pigmented ones. Thus, keratinolytic bacterial load, and their effects, could be higher in unpigmented feathers. This antibacterial effect of feathers in birds' nests was only studied in the Barn Swallow (*Hirundo rustica*): eggs in nests with experimentally-added unpigmented feathers had lower bacterial load and lower probability of hatching failure than those in nests with pigmented feathers. In this thesis, we aim to study the antimicrobial effect of plants and feathers in Spotless Starling (*Sturnus unicolor*) nests during the egg and nestling stages. For this aim, we experimentally manipulated feathers and green plants in starling nests and estimated their effects on: (i) bacterial load (mesophilic bacteria and three bacterial groups that include bird pathogens: enterobacteria, staphylococci and enterococci) on eggshells and nestlings' skin; (ii) several variables related

with nestling health and phenotypic quality (body mass, fledging success, immune response and telomere length and dynamics). We also used artificial nests deployed with Japanese Quail (*Coturnix japonica*) eggs to study the antimicrobial effects of feathers and plants excluding the effects of parental activity, which is known to modify the nest bacterial community. Experimental addition of feathers to the nests reduced bacterial load on eggshells and nestlings. However, we did not find consistent differences between unpigmented and pigmented feather treatments. The feather pigmentation effects depended on bacterial load, nest stage, and nest type (i.e., natural or artificial nests). These results suggest that the antibacterial effect of feathers and of feather pigmentation depends on environmental conditions and/or can be modulated by parental activity. We did not find an effect of green plants on bacterial load of eggshells or nestlings' skin in natural nests, but there was an effect on eggshell bacterial loads in artificial nests. In addition, we detected an effect of green plants in interaction with feather treatments. Staphylococci prevalence on nestlings' skin was lower in nests with aromatic plants and experimentally-added feathers. These results suggest that the antibacterial effect of aromatic plants could depend on nest feather composition. In addition, we found that feathers and aromatic plants in nests had positive effects in nestlings' body mass, immune response, telomere length and dynamics, and in fledging success. We also detected negative relationships between bacterial loads and these variables related with nestling health and phenotypic quality, which suggest that the effects of nest materials on nestling health and quality is driven by their effects on the nest bacterial community. The hypothesis of the antimicrobial effects of feathers assumes that bacteria growing in feathers have high antimicrobial capabilities. In addition, parental activity in the nests could have an influence on the characteristics and segregation of antimicrobial compounds by these bacteria. Thus, we explored the hypothetical higher antimicrobial activity of bacteria from feathers than that of bacteria from eggshells in starling nests and in artificial nests following experimental addition of feathers. We found that keratinolytic bacterial density on eggshells was higher in starling nests than in artificial nests. In accordance with the hypothesis we show that antimicrobial activity was higher in bacterial colonies isolated from feathers than from eggshells and, overall, bacterial colonies from starling nests showed higher antimicrobial activity than the ones from artificial nests. These results suggest that parental activity may favour growth of keratinolytic bacteria with higher antimicrobial capabilities that contributes to shape the nest bacterial environment. Finally, we investigated the starling preference for feather pigmentation and aromatic plants. We found that starlings selected unpigmented feathers to build their nests, both before and during the egg-laying period. However, plant selection was different between both reproductive stages. Before egg laying, starlings did not select between aromatic or non-aromatic plants, which suggest a primary sexual function of green plants in this stage. Conversely, starlings clearly selected aromatic over non-aromatic plants during egg laying, which supports a self-medication function. Overall, all these results support an antimicrobial function of feathers and plants in avian nests, reducing bacterial load on eggshells and nestlings' skin, and improving offspring development. These effects appear to be subjected to important variations, like environmental conditions and/or parental activities. These antimicrobial properties of feathers and plants could be the characteristic that determines the observed active selection of these materials by birds to build their nests.

Academic year: 2016-2017.

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Defences against brood parasitism in the Common Blackbird (*Turdus merula*): plasticity, physiology and evolution.
*[Defensas frente al parasitismo de cría en el mirlo común (*Turdus merula*): plasticidad, fisiología y evolución.]*

Abstract:

The high fitness costs imposed by avian brood parasitism select for the evolution of anti-parasitic defences in hosts, which set the stage for a co-evolutionary arms race, in which brood parasites evolve adaptive counter-defences that select for improved host defences, further parasitic adaptations, and so on. Although these adaptations can be found in all stages of the breeding cycle, the main host defence is the rejection of parasitic eggs, which is a complex process where several stages can be differentiated: egg recognition, decision and reject itself. Throughout this thesis, the study of egg rejection is approached according to this perspective, focusing on the factors that govern each of these stages. Most studies on brood parasitism have focused on the last stage of the egg-rejection process: the action itself, which can be carried out by deserting the parasitized nests, ejecting the foreign egg, or even burying it in the nest. As potential costs associated with each of these egg-rejection mechanisms vary, the choice of the egg-rejection mechanism by hosts should consequently be modulated by a balance between the costs and benefits of the response. In Chapter 1, we investigated whether nest desertion can be considered an egg-rejection mechanism in medium or large-sized hosts. We found that nest desertion cannot be seen as an unequivocal response to brood parasitism in the Common Blackbird *Turdus merula*, a medium-sized potential host species. Thus, future studies on egg rejection using similar species should cautiously consider nest desertion as a response to brood parasitism. Different traits of parasitic eggs (egg mass, colour and size) are proven to affect particular stages of the egg-rejection process, including the decision to eject, which may lead to the acceptance of previously recognized eggs. Chapter 2 shows that hosts are not willing to assume the potential costs associated to the ejection of a slightly heavier egg (low motivation), which turned out in acceptance decisions, confirming that egg recognition is not necessarily followed by egg rejection. Chapter 3 goes one step further and shows how the different stages of the egg-rejection process are independently impacted by different characteristics of parasitic eggs. This chapter describes how colour mimicry hampers the recognition of parasitic eggs (the first stage of the process), thus leading to egg acceptance. On the other hand, although egg size does not seem to affect recognition, it imposes mechanical restrictions on the action stage (the third stage) and delays the decision to eject (the second stage of the process). The existence of acceptance decisions implies that the egg-rejection rate does not necessarily reflect the recognition abilities of hosts, so it is necessary to study other variables clearly attributable to egg recognition to fully understand the rejection process. Given its importance in regulating animal behaviour, endocrine pathways are excellent candidates to continue unravelling the proximate mechanisms underlying egg rejection. In Chapter 4, we investigate how hosts adjust their hormonal state to deal with parasitic eggs, as well as the potential effects of these adjustments on the physical state of hosts. Our results show that a parasitic egg can be, from a hormonal perspective, a stressful factor for hosts since parasitized individuals

showed higher corticosterone levels, and lower body condition, than non-parasitized individuals. Furthermore, unaffected levels of prolactin suggest that blackbirds tended to maintain the parental effort even when parasitized, which may explain the absence of nest desertion in response to experimental parasitism. The important role of decision-making in the host responses suggests that plastic responses might be common among host species. Consequently, Chapter 5 reviews the evidence of plastic defences against parasitic eggs, showing that phenotypic plasticity in egg rejection is less widespread than might be expected. This chapter discusses the factors that could favour the evolution of phenotypic plasticity and its importance in the co-evolutionary relationship between brood parasites and their hosts, where fixed responses seem to be more frequent than previously suspected, even in the absence of brood parasitism. Precisely, Chapter 6 provides experimental evidence on the evolutionary origin of the egg-rejection abilities exhibited by species not currently impacted by interspecific brood parasitism, as is the case of blackbirds. Although previous studies have suggested that egg rejection evolved in this species because of conspecific brood parasitism, our results indicate that the most probable origin of these abilities is a past exploitation by interspecific parasites. Current absence of interspecific brood parasitism in these species could be due to their well-evolved defences, which are maintained even after speciation events. In Chapter 7, we investigated whether there are sex differences in the host response to parasitic eggs, which is particularly relevant in species like blackbirds, in which incubation relies exclusively on females. Contrary to conventional theory, we found that blackbird males recognize and eject parasitic eggs. Interestingly, recognition abilities of males are less developed than those of females, probably due to their looser association to the nest during the incubation stage. The results of this thesis, in addition to the recent new theoretical framework in the field of animal decision-making, highlights the need to update some terms frequently used in egg-rejection studies, as well as the inclusion of new concepts to future studies. This thesis therefore concludes with the proposal, in Chapter 8, of an updated terminology advocating for a consistent use of terms in future works on egg rejection, which could contribute to the advance of scientific knowledge in the field of avian brood parasitism.

Academic year: 2016-2017.

Universidad de Murcia

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In vitro toxicological evaluation of effects produced by cadmium, lead, chromium and selenium in renal and hepatic cells, at concentrations found in three penguin species of the Antarctic Peninsula and associated Islands.

[Evaluación toxicológica in vitro *de los efectos producidos por cadmio, plomo, cromo y selenio en células renales y hepáticas, a concentraciones encontradas en tres especies de pingüino de la península Antártica e islas asociadas.]*

Abstract:

Global and local contamination may be affecting one of the last pristine regions in the world, the Antarctica. Previous studies performed by our research group detected different concentrations of metals in different tissues of three species of penguins located in the Antarctic Peninsula and associated islands (*Pygoscelis antarctica*, *Pygoscelis*

papua and *Pygoscelis adeliae*). These species are considered key indicators for such contaminants. In this thesis we carried out the *in vitro* evaluation of the effects caused by such concentrations of cadmium, lead, chromium and selenium in two different cell lines: VERO, kidney cells and AML12, hepatic cells. We studied basal cytotoxicity and the responses associated to that exposition through the study of: (i) its effect on cellular viability, (ii) structural and ultrastructural changes, (iii) modifications on the cell cycle, (iv) type of predominant cell death, and (v) the cellular stress through the gene expression of genes related with metals toxicity (methallothioneins), cell stress (Heat-Shock proteins), oxidative stress (catalase) and apoptosis (bax). In order to evaluate the cell viability, a colorimetric technique was used, MTT assay through spectrophotometry. We evaluated the effect of the above mentioned metals in cell cycle and the type of cell death produced, using the reactive IP and IP/annexin respectively through Flow Cytometry. Structural and microstructural changes were observed by optic and electronic microscopy and cell stress was evaluated by the probe DCFHA-DA by Flow Cytometry. Finally, the study of gene expression was carried out by qPCR. Cell viability assay using MTT shows that the mean concentration found in adult animals for cadmium is not compatible with cell viability in VERO cell line and we had only 2% of viability on AML12. None of the lead concentrations studied affected strongly cell viability; Chromium concentrations produced a percentage of living cells never higher than 70%. This viability decreases remarkably at the mean concentration found in juvenile animals in VERO cells. Selenium affected cell viability dramatically, with a percentage of living cells never higher than 4%. Data obtained on the effects caused on the different parts of the cell cycle show that cadmium causes a descent in G0/G1 phase and an increase in S phase for VERO cells. This is also the case for higher concentrations studied in AML12, CE_{50} for lead, higher concentrations of selenium and every concentration of chromium. Meanwhile, lower concentrations of cadmium in AML12 (CE_{50}, juvenile and chicks) produced an increase of phase G0/G1 and lower concentrations of lead an increase of G2/M. Cadmium concentrations found in juvenile and adult birds caused apoptosis or necrosis in more than 50% of VERO cells. This was also the case for cadmium concentration found in adults in AML12, CE_{50} of lead, mean concentration of chromium found in chicks and mean concentration of selenium found in adults, juveniles and chicks. The morphological study showed that the most characteristic aspects observed in both cell lines are the inclusion bodies (lead and chromium), strong vacuolization and mitochondrial condensation (every element studied) and a high degree of cell degeneration after treatment with cadmium and selenium. Every concentration used, except for chromium in AML12 cells (no significant differences were observed) and mean cadmium concentration found in adults (a significant increase was determined), caused a descent in fluorescence units (DCFH-DA) as a consequence of the destruction of genetic material and the inability of the cell for producing Reactive Oxygen Species (ROS). Thus, the values in this assay suggest that ROS is in fact a better indicator of mortality than toxicity. Certain concentrations of cadmium and selenium found in the liver and kidney of the three species of penguins produced an overexpression of genes related with cell protection and stress. The results obtained in this thesis, show the possible toxicological risk that contamination in the Antarctic poses for

the populations of *Pygoscelis antarctica*, *Pygoscelis papua* and *Pygoscelis adeliae* at a cellular level in liver and kidney.

Academic year: 2016-2017.

Universidad de Oviedo

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Ecological and evolutionary processes in bird populations and communities along elevational gradients.

[Procesos ecológicos y evolutivos en poblaciones y comunidades de aves a lo largo de gradientes altitudinales.]

Abstract:

Mountains represent an excellent natural system for exploring the evolutionary and ecological responses triggered by the change of environmental conditions. The linear decrease in temperature is the most important environmental variation. It leads to a reduction in productivity and to an increase in seasonality and thus a decrease in breeding/growing season length. These characteristics determine the evolution of specific life history strategies, and constrain the distribution of species as well as the intensity of biotic interactions. Although several studies have explored these biological responses, fewer have analysed their abiotic and biotic underlying mechanisms. The general aim of this thesis is studying the forces that shape the organization of bird populations and communities along an elevational gradient in the Cantabrian Mountains. In order to achieve this objective, the following processes have been analysed: (i) the elevational variation of sexual behaviours; (ii) the elevational variation of inter- and intraspecific survival; (iii) the relative importance of environmental factors and interspecific competition in determining the distribution of closely related species on mountains, and (iv) the elevational variation in the strength of two antagonistic interactions, parasitism and predation, and its environmental determinants. Alpine environments promote in birds a shift toward a "slow" life history strategy, characterized by decreased investment in male sexual signals and increased investment in adult survival. The intraspecific variation of survival is not fully congruent with the interspecific one, although the observed variation suggests that living in highlands may be biologically costly and, therefore, a species may persist with viable populations in alpine areas increasing the investment in survival and reducing territory fidelity. In mountainous environments, the spatial segregation observed in congeneric species is not explained by direct exclusion, i.e. interspecific territorialism, and there is no predominant mechanism driving species replacement. The response of species to environmental factors and biotic interactions is in fact highly individualistic. Antagonistic interactions, such as Haemosporidian parasitism and nest predation, do not vary to a great extent along elevation. Some parasite genera decrease in species and communities at high elevation. However, there is no variation at the population level, suggesting that the low intensity of parasitism may be due to the change in the composition of host bird species along the elevational gradient rather than to the direct influence of the environment. Furthermore, the strength of nest predation does not vary along the thermal gradient. This thesis shows that birds at high elevations adopt a slow life strategy, and that their distribution is not determined by competitive exclusions but rather by a combination of environmental factors. Other interactions, such as parasitism by Haemosporidian protozoa and predation, are seemingly not so relevant.

Academic year: 2016-2017.

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Ecological networks in the Anthropocene: mechanisms and structure of plant-frugivore interactions driving forest regeneration.

[Redes ecológicas en el Antropoceno: mecanismos y estructura de las interacciones planta-frugívoro moduladoras de la regeneración forestal.]

Abstract:

Human impacts such as habitat loss or defaunation are jeopardizing global biodiversity and ecosystem functioning. Biodiversity, traditionally measured as species richness, needs to be approached from a community perspective that considers those components more closely related to ecosystem functions per se. In recent years, an increasing effort has been oriented to the study of ecological interaction networks (i.e. assemblages of species linked by ecological relationships), which have been considered as a useful tool for describing community dynamics and the stability of ecosystems. Despite this effort, we are still far from understanding how and why the structure of ecological networks influences the ecosystem dynamics. This is because there is a lack of studies covering ecological networks from a functional perspective. The general aim of this thesis is to gain insights into the effect of plant-animal mutualistic interactions on ecosystem functioning under anthropogenic impacts. It focuses on the interactions between fleshy-fruited trees and their frugivorous bird species, and considers their derived ecosystem function of forest regeneration. Specifically, it comprises three studies. The first one evaluates the patterns and the drivers of fruit-frugivore interactions at a landscape scale. It is the result of a three-consecutive-year research, carried out in a fragmented secondary forest of the Cantabrian Range to verify whether there is a temporal consistency of the spatial patterns of pairwise interactions based on fruit removal by frugivorous birds. This study also aims to assess the relative importance of different mechanisms driving pairwise interactions under the hypothesis that abundances of interacting species, species identities and neighbourhood context could determine the occurrence and frequency of interactions. The second study evaluates the final functional outcome of plant-frugivore interactions considering two demographic plant cohorts. As a starting hypothesis, it is suggested that incorporating the demographic effect of frugivorous birds on plant species, by considering seed and seedling fate, would lead to structural changes from seed dispersal to seedling recruitment networks. Finally, the third study applies a theoretical approach focusing on species-rich bird and plant communities mimicking a tropical context to study how size-related mechanisms mediate the effects of species defaunation on ecosystem functioning. It is hypothesized that both species' size matching and size trade-offs drive defaunation effects on seedling recruitment. By means of the combination of empirical and simulation approaches based on network theory and mechanistic models, this thesis intends to shed light on the patterns and the mechanisms underlying plant-bird frugivore interactions. Specifically, the results suggest that there is a consistency in the mechanisms driving species interactions in spite of the compositional changes of the species involved in the network across years. Likewise, they evidence that incorporating seed fate into plant-frugivore networks leads to changes in the relative frequencies and the number of paired interactions in plant-frugivore networks across plant regeneration stages. Finally, downsizing in interaction networks due to bird species defaunation might

lead to impoverished seedling communities, especially in networks structured by species size matching and size trade-offs. This suggests that large birds have a disproportional importance for forest regeneration. Therefore, incorporating bird and plant traits within an integrative framework is essential to predict the final functional outcome of plant-frugivore mutualistic networks. Overall, this thesis provides an integrative overview of how the mechanisms driving interactions between fleshy-fruited plants and frugivorous birds define interaction network structures, which, in turn, might finally condition the effect of anthropogenic impacts on the ecosystem function of forest regeneration.

Academic year: 2016-2017.

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Biodiversity and vector-borne diseases: effects of landscape, mosquito and vertebrate communities on the transmission of West Nile virus and avian malaria parasites.

[Biodiversidad y enfermedades transmitidas por vectores: efectos del paisaje y de las comunidades de mosquitos y vertebrados sobre la transmisión del virus del West Nile y de los parásitos de la malaria aviar.]

Abstract:

Emerging vector-borne diseases are an important issue in public health, and both the number and distribution of many of them have increased in recent decades. Global change has contributed to the increase in emerging infectious diseases due to factors such as habitat alteration, the introduction of alien species and climate change. All of these factors can directly or indirectly affect the transmission ecology of vector-borne pathogens, thereby altering the relationships between pathogens, vectors and host populations. In particular, the anthropogenic alteration of landscapes often leads to an increase in the abundance of just a few animal species and an overall loss of biodiversity, which upsets the composition of both vector and host communities. Thus, habitat characteristics may be a key element affecting the transmission dynamics of mosquito-borne pathogens. Here, I use a multidisciplinary approach to identify the factors affecting the transmission of two mosquito-borne pathogens –West Nile virus (WNV) and avian malaria parasites (mainly avian *Plasmodium*)– that circulate naturally in birds in southern Spain. In particular, this thesis explores how the vector (mosquitoes) and vertebrate (birds and mammals) communities and the environment affect pathogen prevalence, richness and/or diversity in wild bird populations living in 15 natural, 15 rural and 15 urban areas. Extensive monitoring of the natural populations of insects and birds was combined with molecular and serological analyses and remote sensing variables in order to gain better knowledge of pathogen dynamics. Using House Sparrows (*Passer domesticus*) as the main host study model, the foremost aim was to assess how landscape and biodiversity affect the transmission of two mosquito-borne pathogens infecting wild birds. In the seven chapters, gathered in three sections, the interaction between (i) potential insect vectors and pathogens, (ii) vertebrate hosts and pathogens and (iii) how biodiversity affects the transmission of vector-borne pathogens under natural conditions, were explored. To identify the factors affecting the relationships between potential insect vectors and bird pathogens, I first identified the impact that urbanization and landscape characteristics (e.g. land use, distance to

water sources and a vegetation index) have on mosquito communities in southern Spain. Human activities were largely responsible for determining the composition of mosquito communities in the area and may increase the likelihood of humans encountering the pathogens that mosquitoes transmit. Also, avian malaria parasites were harboured by different species of mosquitoes, revealing general associations between insect species and parasite lineages, thereby providing evidence for the low transmission specificity of avian *Plasmodium* parasites. The results of this study highlight how mosquito-feeding patterns influence parasite transmission, and ornithophilic mosquito species (feeding mainly on birds) were found to have greater parasite prevalence than those that feed mainly on mammals. In addition, parasite prevalence in mosquitoes varied seasonally, with the highest prevalence recorded in autumn. The diversity of blood parasites in *Culicoides circumscriptus* was also investigated to identify potential nodes of the wild parasite-vector-host transmission network. Overall, these studies allowed identifying the potential insect vectors of avian pathogens and the biotic and environmental factors that potentially affect their prevalence and diversity. By analysing the prevalence of antibodies in resident birds, I also confirmed the local circulation of WNV in 2013 in the same studied area, which underlines the usefulness of active surveillance programs in wild birds in localities with no disease-associated mortalities. Moreover, the influence of vectors and vertebrate communities and environmental characteristics on the prevalence, richness and diversity of the avian malaria parasites infecting house sparrows was investigated in the 45 localities. Factors linked to the vector community were most important for determining the prevalence of parasites in birds, while the host community was the most relevant for explaining variations in *Plasmodium* lineage richness and diversity. Finally, the relationship between pathogens and vector community abundance and composition was tested. Mosquito community composition was identified as a key factor related to the seroprevalence of WNV in these sparrow populations. The abundance of the ornithophilic mosquito *Culex perexiguus* was positively related to WNV seroprevalence. In addition, seropositive birds were only found in natural and rural habitats, which may explain why historically the incidence of WNV in humans in southern Spain –despite local circulation of this virus in wild birds– is currently low. Finally, with the information collected in this thesis, I tested the hypothesis that biodiversity 'dilutes' pathogen transmission. The dilution effect hypothesis proposes that greater biodiversity reduces the possibility of pathogens transmission to humans and/or other species. This hypothesis was tested for the seroprevalence of WNV and the prevalence of *Plasmodium*, *Haemoproteus* and *Leucocytozoon* parasites in birds. Overall, no negative relationship between variables related to biodiversity (diversity index or species richness) and pathogen prevalence was found, which contradicts the predictions of the dilution effect hypothesis. This thesis identifies key variables affecting the transmission dynamics of avian vector-borne pathogens based on the description of the factors that mark the vector community and its interaction with different groups of pathogens. It also includes the study of the biotic and abiotic factors that determine the infection of wild birds and, finally, analyses how biodiversity determines the prevalence of vector-borne pathogens in wild birds. These results allowed me to identify the complex transmission networks of vector-borne pathogens, including those that potentially spread emerging zoonotic diseases and could have an impact on human and animal health.

Academic year: 2016-2017.

Universidad del País Vasco

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The role of seas as a geographical barrier for migratory landbirds. An approach to the Bay of Biscay.

[El papel de los mares como barrera geográfica para las aves terrestres en migración. Aproximación al Cantábrico.]

Abstract:

The East-Atlantic flyway represents one of the main bird migration routes worldwide. Extending between Scandinavia and Iberia it comprises the Bay of Biscay as a potential geographical barrier for migrating birds. So far, the significance of the Bay of Biscay for migrants and its potential impact on migratory routes have not received much attention in research. Ringing data and diurnal observations suggested high autumn migration and low spring migration, both over land and sea. However, actual nocturnal studies on active passerine migration were lacking. When, how and under which circumstances migratory landbirds decide to cross the Bay of Biscay was still largely unknown. The aim of this PhD thesis was: (i) to investigate nocturnal migration patterns and to complement the aforementioned scarce knowledge on migration dynamics at the Bay of Biscay and its potential role as a geographical barrier; and (ii) to assess the radar wind profiler as a new observation tool for ornithological purposes by establishing qualitative and quantitative criteria to extract migration parameters based on a reproducible and objective methodology. In order to address the first objective, all research tools available in the study region deemed suitable for nocturnal studies were employed. Previous knowledge from visual observations and bird ringing at the Bay of Biscay available in literature was also taken into account. Vertical information on nocturnal bird migration was obtained by the boundary layer wind profiler at Punta Galea, Spain, and by a thermal imaging camera at three sites in northern Spain. Horizontal information on nocturnal migration was provided by seven C-band weather radars situated around the bay (three in Spain, four in France). Moonwatching delivered complementary information on species composition. Thermal imaging and moonwatching data were collected in three migration seasons: spring 2014 and 2015, and autumn 2014. Radar data was collected in spring 2015. Information on bird migration in the C-band radar data was qualitatively and quantitatively analysed by a specific bird algorithm. For the second objective, three years (2010-2012) of a good quality historical dataset were first selected to gain an overview over seasonal and diurnal occurrence of biological signals at the radar site. This analysis was based on processed data, i.e. filtered data in which the meteorological products still show presence of biological targets. This data allowed identifying two annual peaks of the number of nights with biological presence, i.e. March/April and August/September. Based on these findings, the first step of a thermal imaging campaign in combination with moonwatching was set up in March 2015 to verify the origin of the presumed biological signals in the radar data and to compare migration intensities at different locations in northern Spain on a regional scale. Once the origin of the seasonal signals had been confirmed as birds, a methodology was developed to extract migration parameters, such as flight altitude and migration intensity, from radar wind profiler data. This pioneer approach was based on unfiltered raw data containing both meteorological and biological data in the sampling volume. This data level was chosen because from the initial review of the filtered data products it was clear that quantitative and qualitative criteria, which reliably separate

birds from other echoes, could only be obtained from unfiltered data. The vertical and horizontal sampling systems provided complementary small- and large-scale information on migration. Thermal imaging allowed collecting migration traffic rates (migration intensities), flight directions, flight altitudes and information on bird composition along the Bay of Biscay. The qualitative and quantitative analysis of the wind profiler data allowed identifying reproducible criteria to eventually extract flight altitudes and migration intensities from raw data independent of weather conditions (e.g. also in precipitation). Weather radars delivered migration traffic rates, flight altitudes and directions. Moonwatching provided additional information on bird composition and confirmed predominance of passerines. The obtained migration parameters were analysed in combination with weather conditions to check for a potential meteorological impact on migration dynamics. The exhaustive selection of technologies employed in this project proved suitable to obtain novel insights on nocturnal migration dynamics at the Bay of Biscay. Vertical historical wind profiler and thermal imaging data indicated pronounced broad-front migration in early spring vs. more eastward (i.e. sea-avoidance) migration in autumn. Spring migration data from horizontal weather radars confirmed sea crossing and revealed a north-south gradient along the French coast, with higher intensity in the south-eastern study area close to the main migration axis of the East-Atlantic flyway. Tailwind played only a marginal role, if any, probably because of the variable and challenging meteorological conditions at the bay. Precipitation would halt migration. For the first time, radar wind profiler data were successfully used to obtain relevant migration parameters comparable to other measurement systems. Future research should extend and refine the promising novel methodology to use radar wind profilers in avian research. Finally, it would be important to use more weather radar data in ornithological studies on the Iberian Peninsula to disentangle large-scale migration dynamics.

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Universidad de Valencia

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Breeding ecology and dispersal capability of wetland birds: a comparison between two *Acrocephalus* warblers with unsynchronized life histories.

[Ecología reproductiva y capacidad de dispersión de aves palustres: una comparación entre dos especies de Acrocephalus *con ciclos biológicos asincrónicos.]*

Abstract:

The Moustached Warbler *Acrocephalus melanopogon* and the Reed Warbler *Acrocephalus scirpaceus* are two insectivorous reed bed nesting passerines. These species are very similar in size, but they differ in several ecological and behavioural aspects, such as migration strategy, breeding phenology and habitat specialization. In this work, we studied mainly Spanish populations of the two species, and our aims were to investigate some aspects of their breeding ecology, to assess their genetic population structure and dispersal ability, and to explore their niche overlap at a sympatric breeding site. We were especially interested in assessing whether the ecological and behavioural differences between both species influence their dispersal ability and how they coexist when breeding in sympatry. We found that the two species are potential competitors for food, and this may explain the reduced spatial and temporal overlap observed during the breeding season. This suggests that ex-

ploitative competition for food may play a more important role within assemblages of reed bed nesting passerines than previously hypothesized. The food samples used to assess the diet of birds were obtained by using the emetic apomorphine, and we found no evidence of harmful effects on birds according to survival probability and mass change. Using microsatellites and mitochondrial DNA data, we found evidences of gene flow among breeding sites for both study species, suggesting that these two warblers are able to compensate for habitat fragmentation. The genetic differentiation among sampling sites was lower in the Reed than in the Moustached Warbler, possibly because of higher dispersal ability, lower philopatry, larger population size, more continuous breeding range or higher capability in crossing natural barriers of the first species. We found evidence for postglacial population growth in both warblers, but such increase and the colonisation of new areas had particular features associated to each species. We studied the dispersal ability of both species also by using ringing data from the Spanish marking scheme; the distribution of dispersal distances did not differ between the Moustached and the Reed Warbler, as well as among age classes. We found cases of long distance dispersal for both species, up to more than 100 km. Such cases were more frequent than expected if the probability of settling of moving birds was constant. The similarity of dispersal patterns between the two species may be due to their phylogenetic relatedness and to similar evolutionary pressures, and is not consistent with the hypothesis of higher dispersal ability in long distance migrants than in sedentary/short distance migrant bird species.

Academic year: 2016-2017.