

PHD-Dissertation Reviews in Ornithology(2013–2014 Academic Year)

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PHD-DISSERTATION REVIEWS IN ORNITHOLOGY (2013-2014 academic year)

Edited by Francisco VALERA

This section includes the abstracts of some of the PhD-Dissertations submitted in Spain during the 2013-2014 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 issue includes exceptionally two theses of the year 2014-2015. We believe it is important to provide this information in this volume instead of postponing its publication to 2015.

Esta sección incluye los resúmenes de algunas de las Tesis Doctorales en Ornitología defendidas en España en el curso 2013-2014 junto con otras no recogidas en reseñas anteriores. Se ha seguido una ordenación alfabética por universidades y, dentro de ellas, por año y autor.

* *En esta entrega se incluyen de manera excepcional dos tesis del año 2014-2015 por considerar relevante ofrecer esta información en el presente volumen de Ardeola en lugar de posponer su publicación al volumen de diciembre de 2015.*

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 biannual prize to the best PhD-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 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 de Alcalá de Henares

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Effects on avifauna of young tree plantations in Mediterranean farmland.

[*Efectos sobre la avifauna de las plantaciones forestales jóvenes en campos agrícolas mediterráneos.*]

Abstract:

Farmlands are important ecosystems for maintenance of global bird diversity in Europe, especially for species of conservation concern. However, many European farmland birds show important population declines over the last decades. Land-use changes represent one of the major drivers influencing these population trends. In the European Union, the Common Agricultural Policy (CAP) has favoured both the agricultural intensification and the afforestation of abandoned and low productive croplands. The conversion of farmland into tree plantations in the European Union has been favoured since 1992 by means of a scheme of aids for forestry measures in agriculture (EEC Council Regulation No. 2080/92), which has resulted in the afforestation of ca. 8 million has. Afforestation may cause severe damage to open habitat species, especially ground-nesting birds, many of which are of conservation concern in Europe. In Spain, these tree plantations are dominated by pine species (*Pinus halepensis*). The main objective of this PhD thesis is to study the effects of young tree plantations (< 20 years) performed on Mediterranean former cropland on bird communities inhabiting these plantations and the surrounding farmland habitat. The specific objectives are: (1) to characterize bird community composition and diversity in the tree plantations and to establish their relationships with local habitat and surrounding landscape characteristics; (2) to test the influence of random sampling

effects, habitat preferences and life history traits on bird species occurrence; (3) to assess the effect of young tree plantations on bird communities inhabiting Mediterranean farmland; and (4) to examine the role of tree plantations on bird nest predation at both tree plantations and adjacent farmland habitat. The applied aim of this research is to provide recommendations to improve tree plantation management. We carried out three observational studies (objectives 1-3) and an experimental study of artificial nest predation (objective 4) in Campo de Montiel (Ciudad Real) between 2011 and 2013. We characterized both local habitat (area, perimeter, connectivity, and vegetation structure of tree plantations) and surrounding landscape (proportion of different land-use types), and surveyed birds at 61 tree plantations and 40 adjacent cropland fields. We also compared species composition and abundance of these communities with the regional avifauna around the study area. Our main results indicate that: (i) bird communities inhabiting tree plantations and adjacent croplands and bird nest predation are affected by the characteristics of both tree plantations and the surrounding landscape; (ii) the random sampling hypothesis explains principally the occurrence of bird species in the tree plantations, so they are colonized by species with broad habitat preferences, increasing population trends and widespread distribution, but do not favour specialist forest species; (iii) the bird community at cropland habitats adjacent to tree plantations is influenced negatively, although with different effects in the winter and the breeding season, which are apparently mitigated by landscape heterogeneity; (iv) high predation rates have been found in the tree plantations and on adjacent farmland habitat, especially in homogeneous landscapes dominated by herbaceous cropland; and (v) these tree plantations do not increase bird regional diversity, so CAP aids to cropland afforestation is not beneficial for biodiversity of this taxonomic group.

The results indicate the low value of tree plantations based on pines for restoration of Mediterranean farmland and suggest the following recommendations for their management: (i) to consider the biogeographic origin of avifauna for forest restoration; (ii) to exclude, and even to extirpate, tree plantations in agricultural landscapes that are highly valuable for open farmland bird species; (iii) to thin and prune tree plantations; (iv) to delve in the study of the effects of generalist predator populations inhabiting tree plantations on bird breeding success and predation risk; and (v) to restore patches of semi-natural woody vegetation in heterogeneous landscape.

Academic year: 2013-2014.

Universidad Autónoma de Madrid

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Assessing human impacts in Antarctic terrestrial ecosystems: human pressures and management strategies in ice free areas.

[*Evaluación de impactos humanos en ecosistemas terrestres antárticos: presiones humanas y estrategias de gestión en las zonas libres de hielo.*]

Abstract:

Previous work on the evaluation of the impact of climate change and Antarctic tourism on chinstrap penguins *Pygoscelis antarctica* at South Shetland Islands suggested a southern migration of chinstrap penguin populations in response to environmental changes. Regional climate warming trend is expected to have profound changes on the fragile Antarctic ecosystems, nonetheless an increasing direct pressure from local activities was also identified. Such human pressures (from c. of 40,000 tourists and 6,000 scientists annually on average) are reaching the few ice free areas of Antarctica (less than

60,000 km² aggregated in total). These are the very same sites where most of the native terrestrial biodiversity breeds or blooms. These results are the foundations of this thesis that combines in situ experiments, field observations and data collection with laboratory analyses and management assessments. During three Antarctic summer field expeditions (2010, 2011 and 2012) a range of sites with human activities (research stations and tourist visited sites like penguin colonies) were inspected. During these inspections the impacts from direct human exposition (such as soil and vegetation trampling, fauna disturbances or species introductions) were studied. Subsequently the respective management practices currently put in place were then examined. Avian stress was explored through feather sampling as a new emerging technique to assess potential human disturbances on faunal behavior. Hormonal corticosterone stress levels contained on feathers were measured with ELISA immunoassays at different sites in order to compare the effects of differential human pressure intensities. An exhaustive comparison between a non-visited colony and a visited one showed significant variations on this hormone levels with depressed values for the latter one. These results follow the habituation hypothesis postulated elsewhere as a result of research on other Sub-Antarctic penguin species. This investigation is also intended to help to assess practical measures such as the appropriateness of the current guidelines of a minimum 5-meter (general) distance to prevent undesired avian disturbances. Relatedly the thesis also explored the implementation challenges on the current usage of the specially protected area system (73 sites). Here the largest fraction of terrestrial protected sites is currently designated for safeguarding marine birds breeding colonies. These studies showed that the different countries of the Antarctic Treaty have very different interpretations of the entry permitting system. Moreover, high visitor densities were demonstrated even at

remote specially protected areas, breaching in practice the designation goals. Parallel the physical damages of direct visitor trampling on the terrestrial ecosystems were simulated on a specific study. Results showed the particularly low resistance of cryptogamic vegetation to moderate trampling intensities. These investigations allow assessing impact minimization strategies and pre-defining specific carrying capacities locally. According to this thesis a holistic strategic approach should be envisaged for long-term effective protection of the Antarctic values contained within ice free areas. Consequently, another set of chapters focused then on two particular case studies: Deception Island and Byers Peninsula. Deception Island is a specially managed area where two stations (including the Spanish Base Gabriel de Castilla) and four visitor sites are congregated. In this area one of the largest chinstrap penguin colonies (with more than 100,000 breeding pairs) can be visited. On this chapter future scenarios are built based on alternative management measures (exploring the range from free action to highly restrictive mandates on the currently existing activities). Intermediate scenarios are proposed to be the most effective, as they are a tradeoff between reaching the necessary consensus between stakeholders while further minimizing the cumulative environmental costs of the prevailing activities. On the other case study (Byers Peninsula) permitted activities are highly restrictive to maintain it as a highly pristine area. Here every single action is monitored to keep any disturbances to a minimal. In this chapter all the costs and benefits from the 10-year running of a field camp were analyzed from all reports to provide an indication of the global footprint and define the appropriate strategies to minimize damages while maximize scientific outputs. Particularly, attention was given to prevent cumulative impacts. Existing sacrifice paths were found to be appropriate solutions under reiterated access to specific locations. These studies

were key sources for the latest revisions of the management plan. At the moment this plan is one of the most scrupulously defined operational frameworks, leaving Byers Peninsula as a referential site for the management of other protected areas. Lastly the thesis also investigated the specific risk of non-native species introduction and spreading capacities. This is explored through a case study on a long-term persisting vascular plant established in the continent (*Poa pratensis*). Results indicate that new species accidentally introduced by human activities can colonize the continent, but often struggle to reproduce effectively. Summer temperatures are postulated to be a limiting factor against the arctic counterpart. However the barriers for invasion are weakened with the regional climatic warming and further human activities expansion. Rapid detection of new introductions, together with development of the predictive capacities in the continent with predictive biosecurity models is proposed to be essential to anticipate and prevent future threats. In this regard such approaches have been initiated as a follow-up of the thesis framework. In summary, this thesis provides an insight of some of the main environmental challenges emerging from direct human activities conducted on ice-free terrestrial ecosystems.

Academic year: 2012-2013.

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Beyond average temperature: distribution of wintering birds at multiple scales.

[*Más allá de la temperatura promedio: distribución de aves invernantes a múltiples escalas.*]

Abstract:

The aim of this thesis is to disentangle the subtleties of the relationship between the thermal environment and the distribution of

wintering birds, at multiple spatial scales. Specifically, the objective is to analyze the relative influence of temperature on species distributions, its interaction with various thermal and non-thermal factors, and the context-dependence of these relationships (i.e., species, season and geographical location). The study is located in Peninsular Spain and Guadarrama Mountain range (central Spain). I use observational and experimental field approaches to control for habitat structure, topography, food abundance and predation risk, from forest patches to landscape, regional and peninsular scales. Fieldwork is carried out with woodland passerines inhabiting mountain oak woods of *Quercus pyrenaica*, and subtle variations in temperature and wind are precisely measured with data loggers. I find that wintering birds respond to natural variations in temperature at multiple scales, selecting the warmest forest patches to forage and the warmest mountain areas and peninsular regions to overwinter. However, temperature per se accounts for a relatively small proportion of the variation in species distribution patterns. Indeed, a sudden extreme drop in temperature is not enough to alter species abundances, or to promote their general redistribution to minimize wind chill. Other non-thermal environmental factors like vegetation structure, predation risk and availability of predictable food resources, seem to be more deterministic in driving winter species distribution than direct measurements of temperature. On the other hand, the influence of the thermal environment goes far beyond average temperature: minimum night temperature, incident sun radiation and altitude related with snow cover are key drivers of species distributions. The relative relevance of all these factors depends on the ecological scenario, varying across species, seasons and geographical locations. I conclude that if we disregard other environmental effects, we will overestimate the influence of temperature on species abundance and underestimate the plasticity of these to respond

to temperature changes. My results highlight the need of fine-grained approaches, based on direct measures of the study organisms and carried out through precise local measurements of environmental variables, to understand the functional mechanisms driving species distribution patterns at wider scales. At all scales, we need to control for other environmental factors when predicting the responses of birds to temperature, under either current or future scenarios of global warming. Otherwise, we are at risk of generating strongly biased predictions that will inflate the magnitude of climate change effects.

Academic year: 2013-2014.

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About eating and not being eaten: vigilance and foraging strategies in wintering Eurasian siskins *Carduelis spinus*.

[*Sobre comer y no ser comido: estrategias de vigilancia y alimentación en lúganos invernantes Carduelis spinus.*]

Abstract:

Animals have to eat a certain amount of food every day to survive. Since trophic resources are usually found in exposed locations, animals are in risk of predation while feeding, and face the well-known trade-off between predation and starvation risks. Animals may reduce predation risk by scanning for predators. However, an increase in vigilance entails an increase in exposure time to predators. Therefore, animals may increase food intake to reduce foraging bouts at the cost of vigilance or may do the opposite. Animals may also reduce predation risk without increasing vigilance by joining groups. However, when food items are concentrated in some defendable patches, individuals will fight to access them, leading to interference

competition. Birds have developed different vigilance and foraging strategies to cope with all these trade-offs. These strategies can be adapted to the environmental conditions and type of predators, and will highly differ according to the genetic, phenotypic and ecological characters of the individuals. In this thesis I investigated how wintering Eurasian siskins *Carduelis spinus* adjusted their vigilance and foraging behaviour to predation risk and competition, and how this adjustment varied according to conspicuousness, residence status and personality of focal birds. I also studied how resident and transient siskins regulated their body mass to predation risk. In order to determine the differential effects of predation risk and competition on the behaviour of siskins, I designed an experiment with three feeders differing in predation risk and interference competition. I captured the siskins every week and marked them with aluminium rings (at first capture) and colour rings (if residents). From each bird, I measured body mass, wing length and plumage coloration cues. I filmed the siskins foraging at feeders from a hide. Then I analyzed the video recordings and selected a sample of birds at each feeder to study the effect of environmental factors, and selected pairs of birds belonging to different cohorts of sex, residence and personality to compare their vigilance and foraging behaviour. I also compared body mass of a large sample of residents and transients in two periods with and without avian predators. I found that siskins adjusted their vigilance behaviour specifically to the environmental conditions. Vigilance to predators, achieved by reducing inter-scan durations, was less costly in terms of food intake rate than vigilance to flock-mates, achieved by increasing scan durations. Siskin males were more brightly coloured and detectable than females, and showed a vigilance system more oriented to predator detection, supporting (together with the correlation between coloration and vigilance

in males) the view of a predation cost to conspicuousness. Resident and transient siskins showed a different vigilance and foraging strategy. Residents were more confident in vigilance to reduce predation risk while transients preferred to reduce foraging bout lengths. Transient siskins were in higher predation risk because of their vigilance and foraging behaviour, and this was related both to their unfamiliarity with the area and their subordination to residents. Proactive male siskins showed a vigilance system that improved their ability to detect predators as compared with reactive males, supporting the view of a behavioural compensation for their personality trait (and not the existence of behavioural carryovers). Resident siskin males adjusted their body mass to the presence of predators at the foraging area, something that transients could not do because of their site unfamiliarity. In general, dominant individuals (whether males, residents or proactive birds) showed a foraging behaviour that prioritized the reduction in predation risk and not the increase in food intake rate, as compared to subordinates. Dominance alone cannot account for our results, although it probably had some effect in all the comparisons.

Academic year: 2013-2014.

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Feeding ecology of Bonelli's eagle *Aquila fasciata*: effects of diet on body condition, vital rates and demography.

[*Estudio de la ecología trófica del águila perdicera Aquila fasciata: efectos de la dieta sobre la condición corporal, las tasas vitales y la demografía.*]

Abstract:

This thesis examines in detail the trophic ecology of Bonelli's eagle in several popula-

tions of Western Europe, which allows testing a number of hypotheses within the theoretical framework of the Optimal Foraging Theory. Firstly, in order to study Bonelli's eagle diet we test the applicability of intrinsic biomarkers such as stable isotope analyses in nestling feathers, offering the first isotopic data for the Bonelli's eagle. Our results show the usefulness of isotopic analyses as trophic indicators both at the individual, territorial and population levels. Then, by using isotopic analyses to assess main prey consumption, we tested which are the effects of diet composition on nestling body condition and on the main vital rates of territorial breeding pairs at different populations with marked ecological and demographic differences. In this regard, it has been shown that higher consumption of preferred prey species improved some nestling body condition biomarkers, while an increase in the diet diversity had an opposite effect. Moreover, a relevant result was the positive relationship between the consumption of preferred prey and reproductive parameters such as productivity, especially at the territory level. It has also been found that those territorial breeding pairs with higher diet diversity had lower productivity, and even lower adult survival. Moreover, the effects of diet on the populations' demographic rates seem an emergent property of the relationship between diet and vital rates at the territory level. Overall, our results indicate that there is a high heterogeneity in diet, nestling body condition and territorial and population main vital parameters both between Bonelli's eagle territories within the same population, and among some populations. These differences have revealed patterns that relate diet with vital parameters at different spatial and temporal scales. Both the development of new techniques for diet analysis and the generated knowledge of the effects of diet on vital parameters provide very relevant and useful information in order to establish protocols for monitoring the feeding

ecology of Bonelli's eagle that can be used for conservation. This aspect is particularly important in the study area, because the monitoring of the diet of a terrestrial predator such as Bonelli's eagle could serve in bioindication studies to detect how human pressure affects the conservation state of those habitats and communities in the Mediterranean ecosystems where the species inhabits.

Academic year: 2013-2014.

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The potential of migratory birds to adapt to global change: lessons from European long-distance migratory birds and Iberian Black-caps.

[*El potencial de las aves para adaptarse al cambio climático: lecciones de las aves europeas migratorias de larga distancia y de las currucas capirotadas Sylvia atricapilla ibéricas.*]

Abstract:

Recent climate change is altering the migratory behaviour of many bird species. An advancement in the timing of spring events and a shift in the geographical distribution have been detected for birds around the world. In particular, intra-Palaearctic migratory birds have advanced arrivals in spring and shortened migratory distances by shifting northward their wintering grounds. These changes in migration are considered adaptive responses facilitating the adjustment of the life-cycle to the phenological changes found in their areas of reproduction. Long-distance and short-distance migrants breeding in the same regions are exposed to the same selective pressures. Yet, while the shortening of migration is well established in short-

distance migrants, hitherto no research has systematically studied the potential for shortening migration distance in long-distance migrants. Adaptive capacity is expected to differ between species differing in the control of migratory behaviour, according to the evidences that suggest the inability of long-distance migrant passerines to undertake adaptive changes. Studies on a population scale could be key to assess the adaptive potential of migratory birds by identifying the factors that contribute to the adjustment of the phenotype to environmental changes. The main aim of this thesis is to give new insights on the capacity of migratory birds to adapt to global change. This goal has been pursued at two different spatial and temporal scales, following a top-to-bottom approach. The first part of the thesis is dedicated to explore patterns and potential causes of the recent shortening of migration distance in trans-Saharan migrants along the Western European flyway. This section is based on the data gathered by the compilation of all published winter observations in the Iberian Peninsula and Morocco of 80 species of European trans-Saharan birds between 1969 and 2006. Since adaptive processes happen at the population scale, in the second section, I studied individual features that may affect the potential for adaptive changes in migratory behaviour in a model species, the blackcap *Sylvia atricapilla*. This second section is based on field data collected between 2010 and 2012 on a partially migratory population of blackcaps from Eastern Spain. The results of this thesis can be summarized in 13 main findings [chapters in square brackets]: (1) At least 41 out of the 80 studied species of European trans-Saharan migratory birds have established wintering populations north of the Sahara [I to IV]. (2) In most species, these populations have significantly increased in the last decades [II, III]. (3) Coastal wetlands are hot-spots where most of these new wintering individuals occur [I, II]. (4) Species

that have larger wintering ranges in Africa and arrive early in spring to Europe are more likely to establish wintering populations north of the Sahara [II]. (5) Non-passerines showed a stronger adaptive response than passerine species [I to III]. (6) Temperature trends in Europe in the last decades are not related to the incidence of wintering of trans-Saharan migrants north of the Sahara [III]. (7) Once trans-Saharan migrants have established wintering populations north of the Sahara, the northern limit of the new wintering range continues to gradually shift northwards [IV]. (8) There is undetected phenotypic and genetic variation in the pattern of juvenile moult of blackcaps [V]. (9) Resident blackcaps, which probably descended from a migratory lineage during the last glaciation, still have migratory appearance in their flight-related morphology [VI]. (10) Residents and migrants from a partially migratory population do not differ in migration-related plumage morphology [VI]. (11) When sharing a wintering territory, resident blackcaps are dominant over migrants, despite their smaller body size [VII]. (12) Resident and migratory blackcaps have differently composed winter home ranges but the same habitat preferences [VII]. (13) The composition of the wintering population suggests the occurrence of sex-biased and environmental-dependent partial migration [VII]. Overall, the results presented in this thesis are consistent with the predictions on adaptive shortening of migratory distances that European trans-Saharan birds need to realize in order to advance spring arrival in response to phenological changes observed under recent climate change. Our data support that this shortening of migration distances at a flyway scale had occurred and is still on-going, at least in species that have more flexible migratory programmes. Population-scaled studies from this thesis contributes to elucidating the specific mechanisms that fuel adaptive potential of migratory behaviour,

and will be a solid basis on which to formulate future predictions about the consequences that these changes will have on migratory birds in general.

Academic year: 2013-2014.

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Major histocompatibility complex in blue tits *Cyanistes caeruleus*: parasitism, sexual selection and immunogenetics.

[*El complejo principal de histocompatibilidad en el herrerillo común Cyanistes caeruleus: parasitismo, selección sexual e inmunogenética.*]

Abstract:

The major histocompatibility complex (MHC) is central in the immune response, and these genes are thought to be of important adaptive significance, particularly for resistance to parasites and pathogens. Antigen detection depends on the MHC structure and function, thus individual MHC alleles may be especially effective at presenting antigens from a particular infection. Associations between MHC alleles and resistance/susceptibility to parasites have been found in vertebrates. Therefore, it is of interest to characterize the genetic components of host immunity and to elucidate the way in which they face the infectious diseases. In addition, numerous observational and experimental studies have shown that female birds prefer males with the brightest and most intense plumage colours. One of the potential selective pressures proposed to explain the evolution of female mate choice is that plumage colour may be signalling health status and parasite resistance; thus, females would acquire selective advantages by mating with colourful males. In chapter one, we investigated such associations in a natural population of a passerine bird, the blue tit

Cyanistes caeruleus, in central Spain. A diverse community of blood parasites including *Haemoproteus* and *Leucocytozoon* species adversely affects this bird population. MHC-I genes were analysed to search for associations among MHC diversity and/or specific MHC alleles, and parasite prevalence and intensity of infection. The statistical analyses revealed that individuals with elevated MHC diversity or carrying specific alleles (Paca UA*104 or Paca UA*108) had higher intensity of infection by *Leucocytozoon* but no significant relationship was detected with *Leucocytozoon* prevalence. Paradoxically, the group of individuals recruited one year later had higher allelic diversity and presented the allele Paca UA*104 in higher frequency, indicating that the association with *Leucocytozoon* had not deleterious consequences. In addition, the males or young birds with Paca UA*104 or Paca UA*108 alleles were more prone to suffer from high intensity of infection. No significant associations with prevalence or intensity of infection were observed for *Haemoproteus*. In chapter two, we investigated the effects from parasite infections on plumage colour. Carotenoids are molecules that birds are not able to synthesize and therefore, must be acquired through their diet. These pigments, besides their function giving red and yellow colours when deposited in feathers, seem to act as immunostimulators and antioxidants in the organism. Hence, only the healthiest individuals would be able to express carotenoid-based ornaments to a larger extent without compromising their physiological functions. Various studies have reported that birds infected by parasites are paler than those uninfected, but, to our knowledge, none of them assessed the possible effect of multiple infections by blood parasites on plumage colour. By comparing the yellow colour in the breast plumage of blue tits, between birds infected by different number of blood parasite genera, we found

that those birds infected by more than one genus were paler than those parasitized just by one. In addition, we have examined the potential role of carotenoid-based plumage colour of blue tits as a long-term indicator of other parameters of health status, such as body condition and immunoglobulin and HSPs (heat shock proteins) levels. Our results indicate that brightly coloured birds had lower HSP70 levels than pale birds, but we did not find any significant association between colour and body condition or immunoglobulin levels. Overall, these results support the role of carotenoid-based colours as indicators of health status in blue tits. In chapter three, we investigated the associations between MHC-I and blue tits mate choice. We also investigated breast yellow plumage colour as a signal of infection status affecting mate choice. To that end, we screened MHC-I alleles corresponding to the peptide binding region (PBR). We found assortative mating according to MHC-I diversity. Females were paired with males that had similar MHC-I diversity. In addition, the apparent MHC compatibility-based mate choice pattern was not statistically different from a random pairing sample. These results point out to the occurrence of a mating system where individuals select pairs similar to each other in MHC-I genes. This finding is in accordance with host/parasite systems where parents invest in parental care and both members of the pair evaluate the quality of its mate. Furthermore, the less colourful females where paired to the more MHC diverse males, suggesting a female searching for high quality males. In chapter four, we partly characterize the MHC class II B in the blue tit. A total of 22 individuals from three different European locations: Spain, The Netherlands and Sweden were screened for MHC allelic diversity. The MHC genes were investigated using both PCR based methods and unamplified genomic DNA with *restriction fragment length polymorphism* (RFLP)

and southern blots. A total of 13 different exon 2 sequences were obtained independently from DNA and/or RNA, thus confirming gene transcription and likely functionality of the genes. Nine out of 13 alleles were found in more than one country, and two alleles appeared in all countries. Positive selection was detected in the region coding for the peptide binding region (PBR). A maximum of three alleles per individual was detected by sequencing and the RFLP pattern consisted of 4-7 fragments, indicating a minimum number of 2-4 loci per individual. A phylogenetic analysis, demonstrated that the blue tit sequences are divergent compared to sequences from other passerines resembling a different MHC lineage than those possessed by the most passerines studied to date.

Academic year: 2013-2014.

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Reproduction and development of the blue tit *Cyanistes caeruleus*: consequences of the Argentine ant *Linepithema humile* invasion on the food web of Mediterranean forests.

[*Reproducción y desarrollo del herrerillo común Cyanistes caeruleus: consecuencias de la invasión de la hormiga argentina Linepithema humile en la red trófica del bosque mediterráneo.*]

Abstract:

The Argentine ant *Linepithema humile* irruption into natural habitats usually produces severe impacts on native arthropods, and especially on ant communities. Impacts of Argentine ant invasion arise from different mechanisms, ranging from direct predation to exploitative or interference competition, and could be transmitted through the food

webs to affect the insectivorous vertebrates. On the other hand, food availability plays a key role during the breeding season and shapes the reproductive fitness of insectivorous birds such as the blue tit *Cyanistes caeruleus*, a small forest passerine which feeds its young on a strictly insectivorous diet. This thesis evaluates whether the Argentine ant invasion disrupts the food web of the sclerophyllous Mediterranean forests affecting bird assemblage. Specifically, we studied if the invaded cork oak *Quercus suber* forests constitute an ecological trap for the blue tit, in which the blue tits' reproductive success gets hampered by the invasion effects on food availability. The study was conducted in the massifs of Les Gavarres and L'Ardenya (Catalonia, north-eastern Iberian Peninsula). Firstly, the invasion consequences on foliage arthropod communities of heathers *Erica arborea* and cork oaks were investigated, paying special attention to the effects on the arthropods included in the diet of insectivorous birds. The invasion effects turned out to be terrible for the native ants, which were almost entirely displaced from the invaded areas. In addition, the invasion altered the food supplies for the foliage gleaner's offspring, mainly responding to a reduction in the availability of caterpillars in cork oaks. We then examined the response of insectivorous birds to these changes, focusing both on the community level and on the reproductive ecology of blue tits. The comparison of the breeding bird populations in invaded and uninvaded areas by censusing birds in transects showed that the Argentine ant invasion does not greatly define the insectivorous bird assemblages, either in terms of the populations' size or of the community composition. Likewise, a detailed study of reproductive dynamics did not provide clear evidence about the reproductive fitness of the blue tit being affected by the alterations detected on the arthropod communities. The reproductive ecology of the blue tit in the

Argentine ant invaded forests was similar to that in uninvaded forests. Breeding blue tits reached equal reproductive success, in terms of productivity and fledgling quality, by feeding the offspring with similar diet composition and prey sizes via a comparable foraging effort. Thus, it is concluded that, at least as measured here, the magnitude of the consequences derived from the Argentine ant invasion on the foliage arthropod communities are below the critical threshold to influence the populations of insectivorous birds in a noticeable manner and to constitute an ecological trap for the blue tit.

Academic year: 2013-2014.

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The ecology and evolution of brood parasite-host interaction: a longitudinal study with ringed individuals.

[*Ecología y evolución de las interacciones parásito de cría-hospedador: un estudio longitudinal con individuos marcados.*]

Abstract:

One of the major challenges of the coevolutionary theory is to understand the spatio-temporal dynamic of the infection processes and the evolution of defenses and counter-defenses between parasites and their hosts. A number of abiotic and biotic factors that can vary spatiotemporally may indirectly or directly affect the dynamic of the interaction. Avian brood parasites and their hosts provide an ideal system for the study of coevolution and in particular, the great spotted cuckoo *Clamator glandarius* and its main host in the Iberian Peninsula, the magpie *Pica pica*, constitutes a suitable system for studying

these issues. This system has provided strong support for an effect of brood parasitism on (i) the reproductive success of the host, and (ii) on the evolution of host defensive mechanisms counteracting the negative effects of parasitism. However long-term studies with marked animals addressing issues related to patterns of host use by parasites, and defense mechanisms, are very scarce in general, and indeed nonexistent for this system. This thesis analyzes in a first block, through cross-sectional and longitudinal studies (based on resampling known individuals in different breeding seasons), the patterns of parasitism in the population. In a second block, through longitudinal studies, questions related to the evolution of defensive mechanisms against parasitism along the life of individual hosts are addressed. The results of this thesis suggest that the pattern of parasitism, at the population level, respond to a probabilistic process based on the spatio-temporal availability of magpie nests and the abundance of cuckoos in the population. In addition, it has been found that the population phenological mismatch between great spotted cuckoos and magpies changes between seasons depending on climatic factors, thus providing an additional explanation to the annual variation found in the probability of parasitism. Also, a longitudinal study reveals a pattern of structured parasitism at the individual level within the population. Indeed, females with a particular combination of traits (nest size, laying date and habitat characteristics) consistently escaped from cuckoo parasitism. The main defensive mechanisms evolved in magpies to counteract the effects of great spotted cuckoo parasitism are nest defense against the parasite before laying (mobbing) and parasite egg discrimination and rejection. The results of this thesis show that magpie pairs differ on their baseline levels of nest defense and their propensity to approach the nest after detecting a potential intruder. We have also found evidence for a direct rela-

tionship between egg rejection and nest defense behavior that may suggest the evolution of a general defensive behavioral syndrome in response to great spotted cuckoo parasitism. The study of the rejection behaviour of magpies throughout their lives shows that some females always accept, others always reject and some others modify their response to model eggs, in all cases switching from acceptance to rejection. Also females tested in their first breeding attempt always accepted the model eggs, even those individuals whose mothers were egg rejecters. A longitudinal analysis showed that the probability of rejecting eggs increased with the relative age of the female, but was not related to the risk of parasitism in the population. All this suggests that the transition toward egg recognition is related to age, being more likely for older females to develop the cognitive and/or mechanical skills necessary for recognition and rejection. In addition, the results of this thesis show that the effect of parasitism on breeding dispersal was mediated by host density, and it was only evident for males. Globally our work suggests that there is no clear evidence that magpies minimized the costs associated with great spotted cuckoo parasitism through dispersing further away. In general, this thesis shows the importance of performing long-term studies through the life of an individual for studying patterns of parasitism and the expression of phenotypic traits and defensive behavior at the population. In the context of coevolutionary dynamics of parasite-host interactions, our findings urge for considering that brood parasitism can be structured within host populations, and the possible influence of abiotic factors beyond the interaction as potential aspects determining the evolution of the interaction. Also, these results suggest that ontogeny may play a fundamental role in the expression of host defenses, particularly for long life host species. Summing up, consideration of these novel aspects (i.e.

structured parasitism, climatic influence and ontogeny), whose importance can only be qualified by performing individual-based and long-term studies, provides intriguing and deeper perspectives for the understanding of the ecology and evolution of avian brood parasites and their hosts.

*Academic year: 2014-2015.

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Structure and functioning of seed dispersal systems in an insular Mediterranean habitat: the thermophilous woodland of Canary Islands.

[Estructura y funcionamiento de sistemas de dispersión de semillas en un ecosistema mediterráneo en condiciones de insularidad: el bosque termófilo de Canarias.]

Abstract:

This thesis studies the structure and functioning of seed dispersal process of fleshy-fruited plants by frugivorous vertebrates (lizards and birds) in insular conditions, specifically in the thermophilous forest from the Canary Islands. For this purpose, droppings of various species of frugivores were analyzed to identify and quantify the seeds dispersed by these animals. One of the most important result was that mutual interdependence between pairs of species involved in frugivory and seed dispersal interactions seems to be higher (more symmetric) on islands than in mainland. Therefore, island populations may be more vulnerable to extinction of their mutualistic species. This could be due to the lower number of species on island ecosystems with respect to continental ones, coupled with a stronger tenden-

cy of species to specialize their interactions (in the context of mutualistic networks). Moreover, unlike most of studies performed in continental ecosystems, I found little effect of species abundance on their interaction patterns, and thereby on network structure. Abundant species are usually sampled more often than rare species, and hence abundant species have more recorded interactions (more connected in the network) than rare species (less connected). Large and complex communities are more prone to this observational bias than small ones. For such reason, our study in a small island community revealed the great importance of species phenotypic traits in determining interaction patterns and network structure. Therefore, the results of this thesis suggest that the structure of interactions, as well as their temporal dynamics may be largely determined by the species phenotypic traits rather than by species abundance, at least in small communities. Finally, the thesis also compared the relative effectiveness of birds and lizards as seed dispersers. Although the saurochory is an eminently island phenomenon, there was a remarkable complementarity between birds and lizards on the various stages that make up the process of seedling recruitment. Therefore, there were some plant species mostly lizard-dependent and some plant species mostly bird-dependent for seedling recruitment. Despite the higher lizard density, both dispersers (birds and lizards) moved similar quantity of seeds. This seems to be due to the lower metabolic rate of lizards with respect to birds. Regarding the quality component of seed dispersal, lizards produced higher seed damage than birds. However, lizards promoted higher seed germination than birds. Finally, including the indirect effect of seed deposition sites for seed germination and seedling survival, despite lizards dispersed more plant species, birds favored the recruitment of a greater diversity of plants.

Academic year: 2012-2013.

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Predictive models applied to the correction and management of bird electrocution on power lines.

[Modelos predictivos aplicados a la corrección y gestión del impacto de la electrocución de aves en tendidos eléctricos.]

Abstract:

Electrocution on power lines is a major conservation problem for a large number of bird species worldwide. Previous works indicated that habitat and technical characteristics of power poles determine the risk of electrocution. The combination of these factors in areas used frequently by sensitive birds concentrated the highest percentage of detected mortality. The isolation and retrofitting of dangerous pylons are effective measures to correct it. However, determining high-risk areas where to apply these measures is difficult. In Europe corrective measures have been implemented only in limited extent areas and lack a strategy for large-scale correction. Spain is one of the countries leading applied research and management in relation to the impact of electrocution on birds but the relevant legislation has been weak and it was not until 2008 that a specific national law (RD 1432/2008) concerning the protection of birds against electrocution was adopted. Despite de new legislation, given the large number of power lines installed and their high impact, its implementation in the entire country is very difficult and it is necessary to design strategies to prioritize the areas for conservation actions. The delimitation of such priority areas is not easy because it should optimize the likelihood of electrocution and the presence of sensitive or

threatened species. The development of large-scale predictive modeling would help to solve this issue. In this thesis we investigate how to identify high risk electrocution areas by means of spatial predictive models in order to establish priority areas and improve the monitoring protocols. Our aims are (i) to study the spatial factors related with bird electrocution on power lines, (ii) to develop a spatially explicit predictive model to identify high risk electrocution areas, (iii) to design a proposal of protected areas for power lines correction, and (iv) to identify indicator species of bird electrocution. As a first step, we evaluated at regional scale the incidence of bird electrocutions in relation to protected areas distribution. Our objective was to assess whether targeting these sites within the new European-based Spanish State legislation against electrocutions is optimal. Results showed that only a small fraction of the total electrocutions occurred within SPA (Special Protection Area), but in the 5 km wide belt immediately surrounding them most of the avian electrocutions were located (*c.* 60% of the total recorded). Therefore, we concluded that the focus on preventative measures being applied within SPAs is inefficient and that action should be targeted in these peripheral areas. Afterwards, to delimitate priority areas we built spatial predictive models derived from bird mortality records, environmental factors and specific sensitivity maps. We also performed a verification and validation process of our predictions to determine its robustness. Our results indicated that large-scale spatial patterns of bird mortality on power lines depended mainly on the combination of two factors, the power line distribution network and the spatial configuration of land uses. In fact, both risk factors are closely linked, *i.e.* presence of irrigated crops and distance to nearest power line. The use of predictive models, by the combination of logistic re-

gression techniques and specific maps of sensitivity, was found to be an effective tool to identify areas of high mortality and, therefore, to select candidates for protected areas. Moreover the predictive models used for identifying areas showed a high temporal stability in the results, and a high sensitivity depending on the algorithm used for calculation. The field validation of bird mortality in selected areas showed that some variables not included in the model, such as the type and design of power pole and factors related with local area management, limited the predictive power. Thus, although at the local scale power pole features is the main factor controlling the probability of electrocution, at the larger scale, other factors such as land use configuration, power line density and presence of sensitive species, would be most important. Verification and validation processes of the selected areas can be improved through planned monitoring of the areas to be evaluated. In this sense, the use of indicator species would help to identify mortality community patterns and optimise the identification of high mortality risk areas. For this purpose, we tested a new approach to select indicator species of high mortality-risk pylons through the evaluation of criteria in accordance with species-specific traits, community characteristics and composition and species co-occurrence patterns. The community of electrocuted birds studied did not show a significant relationship with habitat structure, but had a significantly nested pattern. Our results show that eagle owl *Bubo bubo* was the most abundant breeding raptor, accounted the 29.8% of all mortality events, and co-occurred with 50% of all species. Therefore, this raptor fulfilled all the criteria identified *a priori* to justify its selection as an indicator species of high electrocution risk areas. Finally, the methodology described in this thesis can be easily applied for the selection of high risk area and to optimise the

monitoring of other human infrastructure impacts on wildlife communities.

Academic year: 2013-2014.

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Antarctic penguins: bioindicators of pollution in the Antarctic Peninsula and associated islands.

[*Los pingüinos: bioindicadores de la contaminación ambiental en la Península Antártica e islas asociadas.*]

Abstract:

Antarctic ecosystems could be affected by global and local pollution. Several characteristics of the Antarctic penguins, such as their long life and his position at the top of the food web, endorse them as useful sentinels of pollution in Antarctica. The concentrations of Al, Cr, Mn, Fe, Ni, Cu, Zn, As, Se, Cd, Hg and Pb and organic pollutants (PCBs, PFCs, phthalates and BPA) were assessed by ICP-MS, GC-ECD and HPLC-EI-MS in samples of soft tissues, feathers and stomach contents of Gentoo *Pygoscelis papua*, chinstrap *Pygoscelis antarctica* and Adélie penguins *Pygoscelis adeliae* (33 carcasses and 207 feather samples of living organisms) collected in the Antarctic Peninsula area (2006-2010). The results obtained showed that human pressure is increasing the presence of trace elements in some sampling sites. All the analyzed organic compounds were also found in penguin tissues except for DEHP and BPA. Bioaccumulation and biomagnification phenomena were found for several pollutants. Cd and Se even reached potentially toxic levels.

Academic year: 2012-2013.

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Seed dispersal and forest recolonization in a fragmented landscape. Looking for the footprint of thrushes (*Turdus* spp.) beyond the forest.

[*Dispersión de semillas y recolonización forestal en un paisaje fragmentado. Buscando la huella de mirlos y zorzales (Turdus spp.) más allá del bosque.*]

Abstract:

Frugivorous birds develop a key role in ecosystem functioning. They disperse seeds of many plant species, promoting the maintenance and the recovery of vegetation, and developing thus an important ecosystem service. This ecological function renders frugivorous birds essential for conservation and restoration plans. Nevertheless, the consideration of this bird service as part of environmental management programs must be based on a precise knowledge of the underlying ecological processes. Namely, bird contribution should be studied by characterizing the key species providing the service, the environmental factors that condition its provision and the spatio-temporal scales at which the service operates. Moreover, it must be assessed how human-induced ecosystem degradation alters the ecosystem services provided by birds. The main objective of this PhD thesis is to characterize the role of frugivorous birds in the regeneration process of zoochorous trees in a degraded forest landscape. The study system was the Cantabrian secondary forests, dominated by fleshy-fruited trees whose main seed dispersers are thrushes (*Turdus* spp.). Several studies of this thesis deal critically with the main paradigms describing the influence of habitat characteristics on the sequential

phases of bird frugivory (fruit resource tracking, fruit consumption and seed dispersal). These studies are focused on the spatio-temporal environmental variability resulting from both forest habitat degradation and between-year variation in fruiting landscapes. More importantly, this thesis seeks to evidence the final footprint that frugivorous thrushes leave on forest regeneration. For that purpose, the fate of bird contribution was studied through the different regeneration stages of trees after dispersal (establishment of seedlings and juveniles). The results showed that the activity of frugivorous thrushes is highly influenced by forest cover and fruit availability, representing, respectively, protection against predators and food. Birds used more frequently those landscape sectors presenting both dense forest cover and abundant fruits, and it was in these areas where they feed preferentially. However, the results also revealed an interaction between the effects of forest cover and fruits, with variations on the relevance of each factor depending on the availability of the other one. Namely, the dependence of thrushes on forest cover increased in landscape sectors with scarce fruits, but weakened when fruits were abundant. Similarly, thrushes preferentially used fruit-rich patches when being in those areas where forest cover was low, but relaxed fruit search in densely forested areas. Moreover, the influence of fruit abundance on bird foraging at a small spatial scale can be complex. The magnitude of frugivory by birds on a given individual tree was influenced by the abundance of fruits produced by the other trees (from the same or a different species) standing on its neighborhood. This means that for a tree it could be profitable or disadvantageous (in terms of the number of fruits that birds take from it) to be surrounded by different neighbors. Thus, thrushes' decision about where to feed determines the arising of facilitative

or competitive interactions between the different trees within the forest community. The outcome of these interactions showed important temporal inconsistency as birds optimize their foraging through the landscape in response to between-year variations in fruit production. By conditioning frugivore foraging, forest cover highly influences the spatial distribution of dispersed seeds through the landscape. The few seeds dispersed into deforested areas were deposited very close to forest cover. Nevertheless by influencing frugivore activity, between-year variability in fruiting landscapes can alter patterns of seed deposition concentrated under forest cover, relaxing the restriction of their dispersal into deforested areas. When isolated trees remaining within deforested areas increased their fruit crop, but fruit production was scarce in the forest, birds more often overcame their reluctance to leave the forest. This change in frugivore's foraging patterns cascaded into an increase of seed arrival at longer distances from forest cover, widening and spreading the potential for tree regeneration within degraded areas. Habitat characteristics did not only condition thrushes footprint by influencing their activity but also by affecting the fate of tree seeds after dispersal. The detrimental effects of habitat degradation were maintained during early regeneration stages. Tree seedlings appeared concentrated under forest cover, thus maintaining the initial regeneration patterns determined by bird activity. Nevertheless, bird footprint was blurred in the late regeneration stages. Unfavorable conditions for long-term survival under tree canopy, together with the important role of scrubs protecting seedlings from browsing in deforested areas, altered bird footprint and equalized, at the long term, the magnitude of tree late recruitment between forest and deforested areas. These results highlight the actual service provided by frugivorous birds, given their crucial contribu-

tion to both forest maintenance and recolonization. Habitat degradation influences this service through different ways. It conditions bird activity determining that seed dispersal is mainly nucleated under forest cover, with few seeds arriving in deforested areas. Nevertheless, the spatio-temporal heterogeneity of forest, and the adaptive response of birds, contributes to spread the ecosystem service through the whole landscape. Habitat influence on post-dispersal processes can alter bird footprint on forest regeneration. The presence of protective scrubs strengthens the initially weak bird footprint within deforested areas in the final patterns of recruitment. The conservation of frugivorous birds is needed for the maintenance of forest remnants. Forest extent recover will be achieved by implementing management measures to increase bird presence and the resulting seed dispersal within deforested areas, while simultaneously preserving scrubs that facilitate long-term tree establishment in these areas.

Academic year: 2013-2014.

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Species and ecological interactions conservation in global change context: implications for ecological restoration.

[Conservación de especies e interacciones ecológicas en un ambiente de cambio global: implicaciones para la restauración.]

Abstract:

We are currently attending to the greatest rate of degradation of natural ecosystems of the whole history of the Earth. The increase in human population size and the exponential use of natural resources is the main cause of

such degradation. However, in some areas of the planet this trend is being reversed due to environmental, social and economic factors which are driving land abandonment. Abandoned lands, also denominated as old fields, offer an opportunity for ecosystem recovery. To understand which are the factors modulating ecosystem recovery in abandoned lands is an urgent need to optimize economical resources invested in ecosystem recovery and conservation. In this doctoral dissertation we have studied which are the main biotic and abiotic factors driving the process of colonization of abandoned lands in central Iberia by the native tree Spanish juniper *Juniperus thurifera* L. Seed dispersal is one of the main ecological factors constraining ecosystem recovery in old fields. Thus, we studied the dispersal patterns of the whole dispersal community of *J. thurifera* at the landscape scale accounting for several ecological factors defining environmental heterogeneity (e.g. habitat type, fleshy fruited species cover and tree cover). We found that the arrival of seeds to old fields was not limited due to the differential role of species comprising the dispersal community. Nonetheless the quantity of seeds dispersed in old fields was greatly decreased respect to remnant woodlands. The main dispersers were thrushes and carnivores, being herbivores less relevant. Dispersal patterns for each dispersal guild varied spatially due to environmental heterogeneity. This was especially true for dispersal patterns generated by carnivores which were drastically reduced in mixed woodlands respect to Spanish juniper-dominated woodlands. Thrushes were trustworthy dispersers of Spanish juniper fruits increasing their dispersal patterns in sites where juniper crop sizes were greater. Overall the presence of fleshy fruited species increased the arrival of seeds in all studied habitats. Once established the availability of seeds, we evaluated to what extent post-dispersal seed predation and

seedling establishment could be limiting processes to ecosystem recovery due to previous land use. All spatial scales relevant for such process were accounted for and also the deposition pattern of the main dispersers (i.e. seed clumping). Post-dispersal seed predation was controlled by factors operating at the regional spatial scale being greater in old fields recently colonized than in woodlands remnants. Post-dispersal seed predation was not affected by seed clumping pattern of dispersers. Thus seeds dispersed by thrushes and carnivores were equally predated. Abiotic factors operating at the regional spatial scale due to former farming activities (soil moisture and nutritional condition) did not affect seedling establishment. Intermediate levels of light and nutrients content varying at the local scale were positively related to seedling abundance. Once post-dispersal predation overcome, seedling emergence and survival are the following processes of seed fate. Different disperser guilds present differential morphological (e.g. body size, gape width) and behavioural traits (daily movements, home range) that determine the non-random selection of fruit resources for feeding and also the deposition sites of dispersed seeds. According to this, we performed a sowing experiment with seeds dispersed by thrushes and carnivores to evaluate the influence of their morphological and behavioural traits in seedling emergence and survival probability in the habitats resulted from land abandonment, woodland remnants and old fields. Thrushes preferentially selected seeds smaller than those available in the trees due to their limitation in gape width. Seedling emergence rates were similar for seeds dispersed by carnivores and by thrushes (c. 20%). However seeds dispersed by thrushes suffered a higher mortality rate at the seedling stage than seeds dispersed by carnivores, likely due to their active selection of smaller seeds. Overall, seeds dispersed by carnivores had higher

probability of recruitment than seeds dispersed by thrushes especially in old fields. Thus, given the differential impact on plant recruitment of thrushes and carnivores together with their feeding preferences, modulated by environmental heterogeneity, it is likely that selection forces on seed size may be highly variable at the landscape scale in agreement with the proposed geographic mosaics of selection. To comprehensively determine the effectiveness of the dispersal community of Spanish juniper we integrated all the information previously gathered to perform a stochastic model including all relevant stages and transitional probabilities of recruitment. The outcome of this model was the number of seedlings per square meter resulting from the dispersal activities of thrushes and carnivores, *i.e.* the effectiveness patterns. Thrushes were the most effective dispersers in woodland remnants generating over 80% of recruitment occurring in this habitat while the opposite pattern was found in old fields. Attending to these effectiveness patterns the dispersal community of Spanish juniper resulted to be functionally complementary and not redundant, being both guilds instrumental to regeneration dynamics. This result points out the necessity of preserving the whole diversity of dispersal communities to assure dispersal services and ecosystem resilience after disturbance. Overall greater rates of recruitment were found in woodland remnants respect to abandoned lands. This was mainly due to a greater quantity of dispersal and lower post-dispersal seed predation, being abiotic factors derived of previous land use less relevant. Thus, in old fields not subjected to land use intensification, plant recruitment and ecosystem recovery seem to be controlled by biotic factors, such as seed dispersal and seed predation.

Academic year: 2013-2014.

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Composition of birds, bats and dung beetles communities in agricultural landscapes and protected areas in a tropical dry forest, Costa Rica. [*Composición y riqueza de las comunidades de aves, murciélagos y escarabajos coprófagos asociados a agropaisajes y áreas protegidas de un bosque tropical seco (norte de Costa Rica).*]

Abstract:

The conservation of the biodiversity has focused in continuous forest areas with some degree of protection, underestimating the importance of the heterogeneous agricultural landscape matrix surrounding them. It has been demonstrated today that these agricultural landscapes can contribute to the conservation of the biodiversity. Therefore, we analyzed the influence of structural connectivity, and also the forest cover on the surrounding matrix in 6 different land uses, on the bird, bats, and dung beetles communities. We examined the species abundance and richness for the three taxa in riparian forest, secondary growth forest, live fences, pastures with high tree density and pasture with low tree density in Cañas, Guanacaste, northern Costa Rica. We registered 108 bird species, 42 bat, and 27 dung beetle species. Species richness was higher in the secondary growth and riparian forests for birds and dung beetles. Species richness for bats was higher in riparian forests and live fences. The assemblage of the three taxa varies among the different types of land uses, and it was associated to the land uses with more trees richness. The analysis indicated that the secondary growth forest area, tree richness and the canopy cover percentage were associated to the community of birds present in the agricultural landscapes. We in-

ferred that these land uses favor the connectivity among the different land uses, which allows the species to disperse and explore the resources in the agricultural landscape. The richness of these three taxonomic groups was represented by generalist species from the perturbed areas. Likewise, we registered some forest species, but these were in low abundance. Cañas has a subset of the species of Palo Verde National Park (57.5% of birds, 84% of bats and 90% of dung beetles). Also the agricultural landscape has species that are not registered for Palo Verde (18 birds species, 8 bats and 2 dung beetles), indicating the importance of the heterogeneity and complexity of the different land uses for the conservation of the biodiversity. The maintenance of the areas of secondary growth forests, riparian forest, and live fences are important to keep the integrity of the bird community. Also, it is important to maintain high levels of connectivity among the areas of forests with the other land uses, and to point out the importance of the surrounding matrix and how the configuration of the elements of the landscapes can favor the persistence of different taxa.

Academic year: 2013-2014.

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Breeders and nonterritorial individuals of a long lived species, the eagle owl *Bubo bubo*: differences in space use and movement patterns. [*Reproductores y dispersantes de una especie de vida larga, el búho real Bubo bubo: diferencias en el uso del espacio y patrones de movimiento.*]

Abstract:

Many animal species live in societies in which nearby conspecifics are vital elements

of their social environment, with the nature and quality of their behavioral interactions determining the type of social organization. As a group, birds show a wide range of social organizations where, in some cases, social status gives priority of access to resources, ultimately affecting individual fitness. For example, in territorial species where at least two social groups –breeders and nonterritorial floaters– are recognized, territorial ownership can lead to holders behaving differently compared to the floating counterpart of the population. For this reason, social structure is often considered a key determinant of population biology, influencing fitness, gene flow, and spatial pattern and scale. Nonetheless, nonsocial factors (e.g., environmental condition, food supply) can also affect behavioral interactions, individual relationships, and, ultimately, social organization. In the present thesis, we studied the behavioral differences between individuals of different social status; we focused in particular on the analysis of habitat selection, space use behavior and movement patterns of breeders and nonterritorial eagle owls *Bubo bubo*. The focal radio-tracking of breeders and nonterritorial floaters during 8 years demonstrated that owls perform different behavioral strategies in relation to different life cycle stages, social status and the behavioral trait under study. These observations emphasize the existence of more structured inter-individual relationships than expected. Moreover, previous investigations of social interactions (vocal and visual communication) support the importance of territoriality and social dominance on owls' behavioral decisions. Our results indicate a scenario in which both social and nonsocial factors seem to affect the behavioral mechanisms that regulate habitat selection, space use and movement behavior in different ecological contexts. In contrast to our initial predictions, trophic resource abundance in our study area does not correlate directly with

owls' space use behavior. However, the large abundance of the staple prey across this area, due primarily to management and release of rabbits (the study area serving as game reserve), might actually favor a high density of conspecifics over a reduced area (40 breeding pairs/100 km²) by relaxing environmental constrictions like resource competition (e.g. food). In line with this prediction, we show that territory holders occupy reduced home ranges of high quality for reproduction. Surprisingly, the home range size (mean HR size ~ 220 has) appears to be a direct consequence of landscape structure rather than prey abundance available across the study area. Across the mosaic of territories settled by owls, females –the sex that experiences less social constriction– are those which exhibit wider home ranges that overlap to a greater extent with those of their neighbors. Nevertheless, within the boundaries of their home ranges, adults' behavioral decisions were significantly affected by nonsocial factors such as the biological needs and individual identity. Similarly, external cues like the lunar cycle, act to regulate the time and effort that owls allocated to social (communication) or physiological (feeding) activities. A key finding demonstrated here is that nonterritorial floaters show a tremendous capacity to adapt their behaviour to their immediate needs and social and physical surroundings. As with other territorial species, floating owls show cryptic behaviour, living in a parallel “underworld” where individuals make decisions while considering social constraints, acquired experience and landscape features. At the end of their natal dispersal, the most likely fate for our floaters was to settle close to the natal population while awaiting circumstances that would offer greater reproductive opportunities. In conclusion, the study of the relationships between animals and their environment is a field where ecology and behavior are tightly intertwined. In my opinion, and as

stressed in the present study, social organization is a key determinant of population biology with important implications on spatial processes.

Academic year: 2011-2012.

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Incubation and hatching patterns of the great tit *Parus major* in a Mediterranean environment: causes and consequences.

[*Patrones de incubación y eclosión del carbonero común Parus major en un ambiente mediterráneo: causas y consecuencias.*]

Abstract:

The bird-nest unit maintains a suitable microclimate for embryonic development. Therefore, for the study of incubation patterns and processes it is necessary to consider both the nest characteristics and the behaviour of the incubating birds. The incubation behaviour is especially interesting when only one parent (usually the female) incubates, since it must balance the time spent incubating (“sessions”) with the time spent feeding out of the nest (“recesses”). On the other hand, incubation can be initiated with the laying of the last egg, or before or after completing the clutch. Both the timing of the incubation onset, and the incubation rhythm (temporal pattern of sessions and recesses), contribute to determine the hatching pattern (from asynchronous to practically synchronous). Thus, studying nest characteristics and the incubation rhythm, and the factors that might affect them, is important to understand life cycle trade-offs, which may have important consequences for the breeding performance. Our general aims were to describe the characteristics of the great tit *Parus major* nest, their intra- and inter-

population variability, and their reproductive consequences, and to describe incubation and hatching periods in a Mediterranean environment, to explore some of the causes that could affect them, and their consequences on breeding performance. We hypothesized that parental characteristics, nest, and environmental conditions can affect the duration of incubation and hatching periods, having consequences on the breeding performance. This thesis is developed in areas of the Mediterranean region of Eastern Spain (mainly in Sagunto, Valencia) and includes data for the period 1988-2010. The study species, the great tit, is one of the most widespread passerine birds, it breeds in holes, only females build the nest (basically with moss) and incubate the eggs, it has a typically asynchronous hatching, and it is altricial. The populations included here bred in nest-boxes, which were visited regularly to estimate the relevant parameters (basically from first clutches), and take the appropriate measurements from nests, eggs, nestlings and parents. We injected phytohemagglutinin to some nestlings to determine their health status. We also recorded incubation rhythms and nestling and parental feeding rates for some nests by using transponders and thermometers. We performed two experiments (during the incubation period): (i) construction of artificial nests of good and poor quality, and (ii) cooling and heating nests. We found no significant relationship between the quality of the parents and the nest, but we did find that higher quality nests were associated with better breeding performance. The material used in the nests of several Mediterranean areas was the same, but with different weights and proportions. Only in Sagunto, hatching success was higher in nests with more moss. The condition of the nestlings was dependent on the amount and quality of certain materials. Hatching success was higher in good nests than in controls. The nest, regardless of the quality of the parents, may contribute to

breeding success and, to our knowledge, this is the first study where this relationship has been demonstrated experimentally. In Sagunto, the incubation period lasted on average 13.3 days, while the hatching period lasted 1.7 days. The incubation period was longer in years where clutch size was lower, as the incubation started earlier in the laying sequence, and earlier in the breeding season. The hatching period was longer as the incubation period decreased, as clutch size increased, and as the incubation started earlier in the laying sequence. The hatching asynchrony was higher in nests in which the onset of incubation was earlier relative to clutch completion. In Sagunto a female left the nest-box in average 7 minutes after sunrise, and entered it to overnight 44 minutes before sunset, being the mean duration of the active day 12.5 hours. During the active day an incubating female left the nest an average of 1.8 times per hour, performing sessions of around 26 minutes, and recesses of about 12 minutes. During the active day females dedicated about 8.25 hours to incubate; considering the night period (11.5 h), females dedicated 20 hours per day to incubate. The active day was longer as daylight hours increased. Females made shorter recesses as incubation progressed. During the early incubation stage, the recesses were longer as the clutch volume decreased. Females with greater wing length made shorter sessions. During the late incubation stage, females in better condition, and/or those paired with better quality males, spent more time out of the nest-box. We show for the first time in a bird species that nest attentiveness (% of incubating time) for 24 hours is very similar between populations ranging from Norway to Spain. Though nest attentiveness during the active day (%) was lower in Sagunto than those of any other European population studied, they compensate this deficit by incubating during the longer nights. The mean length of sessions and recesses of incubation

did not follow a clear latitudinal pattern, although perhaps recesses are longer in extreme than in central populations. Finally, our experimental study showed that females whose nests were heated spent less time in the nests than control or cooled ones. Different responses to heat stress suggest that not always “heat is good” and “cooling is bad”. We think that a large-scale study is necessary, using the same species and protocol in different environmental conditions.

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Migration strategies of *Acrocephalus* warblers in the Iberian Peninsula.

[*Estrategias de migración del género Acrocephalus en la península Ibérica.*]

Abstract:

The migration strategies of *Acrocephalus* warblers, the reed warbler *A. scirpaceus* and the sedge warbler *A. schoenobaenus*, during the autumn migration in the Iberian Peninsula were studied at two levels: on one hand, the spatial organization of migration within Iberia; on the other hand, the behaviour at stopover areas. For the study of the spatial organization of migration in Iberia, we used ringing data of birds captured at a net of sampling sites, covering the main migration routes within Iberia. Reed Warblers passing through western Iberia (WI) had shorter wings than those in central (CI), eastern (EI) and southwestern (SW) Iberia, suggesting that birds in WI migrated shorter distances, a fact also supported by recovery data. Although reed warblers showed some population overlap when passing through Iberia, we found that birds passing through EI and CI came from areas further to the east (continental Europe) than those passing through WI (mainly British Isles), thus supporting

parallel migration of different populations within Iberia. Reed warblers tended to converge in south western Iberia, suggesting an effect of nearby geographical barriers. Reed warblers in Iberia had the necessary fuel to arrive in northern Africa but not to tropical Africa. However, body mass patterns varied depending on the geographical region (EI, CI, WI). Date did not affect body mass in CI and WI, but it did in EI, where heavier birds tended to pass later. Thus, the factors shaping body mass of reed warblers in Iberia before the sea crossing to Africa seemed to be more complex than just the distance to this geographical barrier, with underlying stopover quality-associated factors possibly playing a relevant role. For the study of stopover behaviour, we used ringing and radio tracking data obtained at a relevant Iberian stopover site, the Jaizubia marshlands in Guipúzcoa. Firstly, we modelled landing probabilities using reverse-time capture-recapture models for the sedge warbler. As expected, rain showed a positive effect on the landing probabilities of sedge warblers at Jaizubia, indicating that birds avoid flying during rainfall and prefer to interrupt their migration, but wind conditions did not influence landing probabilities. Secondly, we modelled departure probabilities using Cormack-Jolly-Seber models. Sedge warblers were more likely to depart with high tailwind values and late in the season and, contrary to expectations, with decreasing sedge warbler abundance. Selecting tailwind values allows birds to cover longer distances with the same energy amount, thus saving energy and time. The results also show how birds passing later in the season were more likely to depart from Jaizubia, suggesting that time pressure increases as the season progresses, which force migrants to increase their migration velocity with date. The negative relationship between bird abundance and departure probabilities may be explained by two hypotheses: a high sedge warbler's abundance is an indicator

of high food (i.e. aphids) availability and/or, a high sedge warbler's abundance reduces individual predation risk, allowing birds to reduce anti-predator awareness and to maximize their foraging and fuelling rates. Additionally, the proximity of stopover sites to a geographic barrier (the sea band between Iberia and Africa) modified the importance of the factors that migrants take into account when deciding whether to stay or leave stopover sites. In northern Iberia sites, departure probabilities of reed warblers were independent of fuel load, whereas in southern Iberia birds were more likely to depart with higher body masses. Also, departure probabilities from the different stopover sites were not related with the fuel deposition rate experienced by birds in those sites. Reed warblers departed irrespective of wind conditions in both regions, contrary to what was found for sedge warblers at Jaizubia. The wind-selectivity (or the lack of it) in the initiation of migratory flights may be related to the type of migration strategy adopted by the different species (length of flight bouts and amount of fat reserves accumulated). Finally, we studied the spatial behaviour and habitat selection of

reed warblers at Jaizubia with radio tracking data, considering three different groups: local adult birds which were still at their breeding site in Jaizubia, migrating first-year birds (originating from beyond Iberian peninsula), and migrating adult birds. Overall, reed warbler established non-exclusive home ranges, smaller than the whole study area. Migrating first-year birds had larger home ranges than both local and migrating adults and to move more widely within Jaizubia. They also showed lower fat deposition rates than adults, although differences were not significant. The proportion of habitats in home ranges (reed-beds and tidal flats being the most abundant habitats) was similar amongst groups. The spatial distribution and habitat use of organisms have been theorised to follow an ideal-free or ideal-despotic distribution. However, according to our results, other complex underlying mechanisms apart from habitats availability and density of birds may play an important role in shaping the spatial behaviour of birds at stopover sites (e.g. site familiarity).

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