# PHD-DISSERTATION REVIEWS IN ORNITHOLOGY (2012-2013 academic year)

# Edited by Francisco VALERA

This section includes the abstracts of some of the PhD-Dissertations submitted in Spain during the 2012-2013 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.

Esta entrega incluye los resúmenes de algunas de las Tesis Doctorales en Ornitología defendidas en España en el curso 2012-2013 junto con otras no recogidas en reseñas anteriores. Se ha seguido una ordenación alfabética por Universidades y, dentro de ellas, por año y autor.

## 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 Ph Dissertation included in this section. The prize is awarded in the corresponding Spanish Ornithological Conference. We are looking forward to hearing from you, also as proof of the relevance and quality of ornithological research in Spain.

# Nota informativa:

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

García Ripollés, Clara

E-mail: clara.garcia@uv.es / clara.ripolles@ gmail.com

Supervisors: López López, P. and Urios Moliner, V.

Biology and conservation of two scavenger species breeding in the East of the Iberian Peninsula.

[Biología y conservación de dos especies necrófagas nidificantes en el este de la península Ibérica.]

# Abstract:

In the last century, raptor populations have suffered severe widespread population declines. As a consequence, many attempts to improve the conservation status of these species have been conducted in recent years. Complete knowledge of population biology and ecological requirements and limitations of threatened species are required to develop management plans and conservation strategies. Obtaining accurate data on broad aspects of the biology of raptors has many disadvantages, among which we can highlight the major areas needed to sustain their populations, the nesting specialized requirements, or conflicts with human activities. This doctoral thesis was focused in the study of the basic biology and ecology of two scavenger species in the field of conservation biology. The study was focused on two populations of Eurasian griffon vulture Gyps fulvus and Egyptian vulture Neophron percnopterus which remained poorly known in the East of the Iberian Peninsula so far. Therefore, the main objective of this thesis was to provide information on the basic biology of both populations, and to get insight into their knowledge to improve their management and conservation, both locally and worldwide. The specific objectives of the thesis

of the species in the study area, and provide an analysis of the environmental variables recorded at griffon vulture's colonies and their relationship with reproductive performance; (ii) report the breeding status of the Egyptian vulture's population in eastern Spain (analyzing population trend and breeding performance) and describe nest characteristics and location and its relationship with breeding performance; (iii) apply habitat modeling techniques using Generalized Linear Models (GLZ) to generate not only explicative but also predictive habitat suitability models and to stress those ecological factors that affected the species' nesting habitat preferences at two spatial scales; (iv) provide information on ranging behaviour of eight Eurasian griffon vultures tracked with GPS satellite, trying to answer the main questions on when, how far and where vultures range, and provide information about frequently-used roosting places and their relationship with the vulture restaurants located in the study area; (v) describe the migratory routes, timing of migration, migratory parameters and ranging behaviour in wintering areas of two adult Egyptian vultures tracked by global positioning system (GPS) satellite telemetry for the first time; (vi) present the results of the management regime of a vulture restaurant located in the inner of Castellón province during two-years period; and (vii) incorporate demographic and environmental stochasticity into the construction of individual-based models. integrating the effects of supplementary feeding, poisoning, pollutant ingestion and wind farms in a Population Viability Analysis (PVA) of the Eurasian griffon vulture

were (i) describe the population status, reproductive performance, breeding success and productivity of the Eurasian griffon

vulture in Castellón province, report the range expansion observed in the last decades and Egyptian vulture in Spain. In addition, it was performed a comprehensive sensitivity analysis in order to explore the effects of possible management actions aimed at maintaining stable populations of both species and to assess the risk of extinction in the medium and long term.

Academic year: 2011-2012.

Belda Antolí, Antonio

E-mail: antonio.belda@ua.es

Supervisors: Peiró Clavell, V. and Seva Román, E.

Sustainable management of hunting resources in a landscape mosaic gradient in the Marina Baja region (Alicante).

[Gestión sostenible de recursos cinegéticos en un gradiente de mosaicos del paisaje en la comarca de la Marina Baja (Alicante).]

#### Abstract:

The district of Marina Baja enjoys a great hunting activity that is translated into a huge territory for this occupation. Around 66.1% of the surface of the land is considered of hunting interest. Statistical data show an increasing number of captures for several game species like rabbit Oryctolagus cuniculus, common wood pigeon Columba palumbus, red-legged partridge Alectoris rufa, wild boar Sus scrofa, red fox Vulpes vulpes, Eurasian collared dove Streptopelia decaocto and common magpie Pica pica. In contrast, other species are decreasing, like the European hare Lepus europaeus and the Eurasian woodcock Scolopax rusticola. A third group of species (thrushes and starlings) have a varying proportion of captures in recent decades. The relationship between game species captures and land use emphasizes that irrigated and rainfed fruit orchards are the most suitable ones for species like the partridge, the rabbit, the wood pigeon, the European turtle dove Streptopelia turtur,

the Barbary sheep Ammotragus lervia, the common starling Sturnus vulgaris and the collared dove. The relationship between hunting statistical indexes and landscape descriptors concluded that the index of landscape shape and the fractal index are the descriptors correlating positively with the highest number of species. The abandonment of traditional agricultural crops and urbanization are the most important disturbing agents, leading to increased fragmentation of the landscape mosaic and to the creation of small scattered patches. In Marina Baja rabbits prefer irrigated crops located in the coastal region with a semiarid ombrotype matching the Thermomediterranean thermotype. This indicates that, despite being a very fragmented area with high urban density, the rabbit is able to adapt to diversified landscapes with strong anthropic activity. Wood pigeons in Marina Baja prefer landscapes with rich patches dominated by natural vegetation with Mesomediterranean thermotype and dry ombrotype. The use of GIS has enabled a simple way to integrate information from different sources, such as observations of wild boar (KAI), combined with the result of cost-distance analysis, and generate a potential distribution model that reflects the high versatility of this species. The magpie prefers areas with Mesomediterranean thermotype, located north of the district of Marina Baja, and avoids coastal areas where the density of urban patches is highest. This shows that, although the magpie is perfectly adapted to urban settlements, it still prefers rural ones with rainfed agriculture. Hunting areas ("cotos") controlling the population of magpies have a positive effect on other game species, namely the partridge. Surveys to hunting managers yielded data on the abundance and evolution of populations of game species.

Academic year: 2012-2013.

#### Mellone, Ugo

E-mail: ugomellone@libero.it

Supervisors: Urios Moliner, V. and López López, P.

Movement ecology of long-distance migrants: insights from the Eleonora's falcon *Falco eleonorae* and other raptors.

[Ecología del movimiento de migradores de larga distancia: Ejemplos con el halcón de Eleonora Falco eleonorae y otras rapaces.]

# Abstract:

This thesis is based mainly on the results of satellite tracking of Eleonora's falcons, and also of four species of soaring migrants (osprey Pandion haliaetus, marsh harrier Circus aeruginosus. Egyptian vulture Neophron percnopterus, short-toed snake eagle Circaetus gallicus). The movements of Eleonora's falcons are affected by both external (landscape, wind) and internal (age) factors. During their autumn migration across Africa, Eleonora's falcons change their behaviour according to the landscape characteristics of the crossed regions. Changes in flight speed, time budget and straightness promote differences in the daily flight ranges, also among adult and juveniles. Wind conditions affect the daily forward and/or perpendicular components of movement's rates. During the crossing of ecological barriers, such as the Sahara desert, they reach higher daily flight ranges thanks to a higher number of travelling hours, including a consistent amount of nocturnal flights. They are also more dependent of wind conditions than in other regions, regardless the age, with both tailwind and crosswinds shaping the migratory routes. In the remaining African regions the rate of nocturnal migration is lower than in the desert, as well as flight speeds, thus promoting lower daily distances. In particular, in the Sahel, a more benign region in terms of food availability, juveniles show slower speed, lesser straight paths and a higher amount of stop-over days

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than adults, perhaps in order to take advantage of foraging opportunities, in response to a lower efficiency during pre-migratory fattening. Wind conditions seem to be less important during the crossing of these regions, although crosswinds have a significant effect in Equatorial Africa. The likely reason of this pattern is that perhaps Eleonora's falcons fly and stop in relation to foraging opportunities rather than in relation to wind, especially in the Sahel and therefore, at least at the daily scale, wind conditions seem to be less important. In order to reach Madagascar, Eleonora's falcons have to fly non-stop over the sea for at least 600 km ca. While during autumn migration they try to minimize this distance, probably because winds are generally less favourable, during spring they reach Africa more directly, flying over water for 1200-1500 km and showing a strong flexibility, since the same individual is able to change the route in a given year in order to avoid low pressure areas where bad weather conditions can enhance mortality risks. The main seasonal difference in the geometry of migration routes is promoted by the significant divergence around the Equator, where routes lie more in the west during autumn and in the east during spring. This is probably dictated by seasonal differences in the distribution of trophic resources. Favourable conditions for foraging occur in Ethiopia during April, as suggested by the higher number of stop-over days in those regions. This pattern shapes a loop migration system that seems to be the rule among all the studied population of the Eleonora's falcon (Spain, Sardinia, Croatia, Greece), and may be widespread also among other long-distance Palearctic migrants. Taken together, these evidences (nocturnal migration, individual flexibility, long sea-crossings) suggest the Eleonora's falcon has an orientation system that may work independently of the visibility of landmarks or, at least, not relying only on these topographic features. Still, it remains unknown which cues it uses to reach a narrow wintering area as Madagascar, especially when considering inexperienced juveniles migrating alone. The circadian pattern of hourly speed and flight altitude in four species of soaring raptors crossing the desert highlights the importance of thermal strength, with a clear peak just after midday. Instead, at the daily scale, their performance is affected mainly by tailwind support. Migration speed is higher for species that have to cover an overall longer distance (> 5000 km: osprey and marsh harrier) rather than for species with a shorter distance between breeding and wintering grounds (Egyptian vulture and short-toed eagle). Finally, in agreement with predictions, adult individuals migrate more quickly during spring rather than during autumn. Outside the migration periods, when they perform long-distance directional flights, Eleonora's falcons move within small ranges. with shorter flights and in a non-directional way, using different habitat according to the distribution of trophic resources and showing among-year site fidelity to both wintering and pre-breeding areas. Wintering is the most consistent part of the annual cycle, accounting for a 41%. Eleonora's falcons spent the winter in Madagascar, where they select degraded humid forests and cultivations close to pristine humid forests, probably to take advantage of a spill-over effect of their prey (insects) into open areas where hunting is easier than in the dense forest. During late spring and summer Eleonora's falcon show a pre-breeding phase where they alternate stay in the breeding colony with long visits to inland areas that can be even 400 km distant and are characterized by a variety of environments offering, in this period, better foraging opportunities (e.g. insects' concentrations) than the breeding colonies. Instead, during the breeding season, Eleonora's falcon mostly moves to the open sea to hunt migrating passerines during morning, visiting inland areas with fresh-

water availability during afternoon and staying in the colony during night. The conservation of migratory species cannot be focused just on one area/season/life stage of a given species but should integrate local actions, spanning throughout the whole annual cycle, into a global strategy.

Academic year: 2012-2013.

# Universidad Autónoma de Barcelona-CREAF

Lapiedra González, Oriol

E-mail: o.lapiedra@creaf.uab.es Supervisors: Sol Rueda, D. Behavioral changes, ecological niche and adaptive diversification of pigeons and doves. [Cambios de comportamiento, nicho ecológico y diversificación adaptativa en Columbiformes.]

# Abstract:

The extraordinary diversity in ecology, morphology and behavior of species across the tree of life has long interested researchers. Understanding why and how lineages diversify in phenotype and species numbers remains, however, a major challenge in evolutionary biology because evolutionary diversification is a complex process influenced by a number of factors of diverse nature. This thesis aims to provide an integrated picture of the mechanisms that have led to the current biological diversity of a major vertebrate clade by incorporating a crucial factor that has largely been neglected in evolutionary studies: the role of behavior. We have investigated whether changes in behavior can shape evolution by allowing individuals to modify the way they interact with their environment -their ecological niche-. Such changes can modify the way selective pressures affect individuals within populations, thus favoring divergent selection that can promote adaptive diversification.

Thus, the thesis is divided into two main parts: in the first part, I show how behavioral changes may explain current patterns of phenotypic and taxonomic diversity in a major bird clade: Columbiformes. The second part is centered on identifying which are the main ecological processes that drive behavioral changes at an individual-level. I address four main goals that have been evaluated using both phylogenetic comparative and experimental work in pigeons and doves. The first objective has been to describe the influence of behavioral changes in the adaptive diversification of the lineage. In this work we provide evidence for the behavioral drive hypothesis, which predicts that changes in behavior can spur evolutionary change. We have used a novel retrospective approach based on recently-implemented evolutionary models to show that: (i) changes in the foraging behavior have been associated with a displacement in the phenotypic optima regarding functionally-relevant morphological traits along the evolutionary history of Columbiformes, and (ii) such behavioral modifications have also been associated with the acceleration of morphological evolution. This is, each time an arboreal foraging behavior has been acquired, new selection pressures have led to directional, fast changes in tarsus and tail lengths. Such changes are consistent with functional morphology predictions that long tarsi should be favored for locomotion in the ground while short tarsi and long tails provide increased perching stability in arboreal lineages. The second work has claimed for the importance of integrating such behavioral changes with geographical and ecological factors in order to provide a more complete perspective of the evolutionary history of vertebrate lineages. In this work, we have shown that behavioral key innovations -which have been shown to be crucial for the adaptive diversification of the lineage in the previous work-only occurred when lineages colonized areas with increased

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ecological opportunities (i.e. islands). Furthermore, we provide first evidence for a key prediction of the behavioral drive hypothesis: speciation rates were higher after the acquisition of the key evolutionary innovation -but were not higher when animals became geographically isolated-. The third chapter of the thesis describes a new method implemented to better study differences among the ecological niches of individuals and populations, which is necessary to link behavioural and evolutionary changes. We show the importance of taking into account the similarities among resources for precisely estimating niche metrics and provide an empirical example. Moreover, our new framework allows researchers to build a resource space which facilitates computing new niche metrics, and conveniently interpreting results in a graphical environment that can be applied to the species-, population- or individual-level. Finally, we use an experimental approach in feral pigeons Columba livia to understand the origin of existing ecological variation within populations, focusing on the role of increased competition and previous experience as main drivers of niche differentiation among individuals and provide direct empirical evidence that: (i) individuals consistently differ in their resource preferences, even when they lack any previous experience; (ii) populations with increased intra-specific competition regimes show more individual specialization and, finally, (iii) we use a novel experimental approach to provide direct empirical evidence that naïve individuals can plastically shift their foraging niches to handle increased competition, causing a rapid modification of ecological interactions. Finally, we show how such selective regime increased individual specialization. Altogether, we try to provide an integrative view showing how ecological processes may cause behavioral changes that can sometimes present novel selective pressures. Populations may adaptively respond to such new selective

pressures by evolving to novel directions. This can spur phenotypic evolutionary rates. Finally, as we have shown in Columbiformes, such key innovations (i.e. colonization of an arboreal foraging) may sometimes allow a lineage to colonize a new adaptive region and this may lead to increased speciation rates.

Academic year: 2012-2013.

#### Universidad de Barcelona

Ponjoan Thans, Anna

E-mail: aponjoan@yahoo.com Supervisor: Mañosa Rifé, S.

Ranging behaviour and habitat use in the little bustard *Tetrax tetrax* during the breeding season: conservation implications in farmland areas.

[Uso del espacio y del hábitat en el sisón Tetrax tetrax durante el periodo reproductor: aspectos aplicados a la conservación en hábitats agrícolas.]

# Abstract:

This thesis deals with the breeding biology of the little bustard Tetrax tetrax in a cereal pseudo-steppe (NE-Spain), and develops methodological issues which could be relevant for conservation purposes. The ranging behavior of males was highly variable and was mainly determined by the availability and distribution of high-quality habitats. It was also dependent on male social dominance, as males tended to reduce and concentrate their home range as age and social status increased, as indicated by the inverse association between range size and display activity. In relation to broods, we identified two main ranging patterns. Early broods concentrated their activity in relatively small areas situated in high-quality habitat, while late broods moved across wider ranges of low-quality habitat. The use of small areas was associated with successful broods. The existence of these two ranging patterns is

mainly due to the timing of cereal harvesting in relation to the breeding phenology of each brood. Breeding success in the study area (0.27 chicks/female in 2006-2008) was not enough to guarantee the long term viability of the population. Hence, breeding success of little bustard populations inhabiting cereal pseudo-steppes should be a management priority. We recommend the enhancement of habitat quality, by delaying harvest when possible and by promoting the presence of fallow fields, steppe-scrubland or leguminous crops with vegetation cover during the entire breeding season, in order to increase food and shelter availability in cereal agro-systems. Our results highlight that a combination of trapping methods are needed to capture little bustards for research purposes. We recommend the use of snares to capture displaying males, funnel traps to capture females and/or mediumsized to large chicks, and hand-held nets to catch small chicks. We do not recommend capture in flocks owing to the low capture success and the high occurrence of capture-related disorders. We observed that little bustard is fairly susceptible to capture myopathy. We showed that the occurrence of such disorders could be reduced by keeping handling time below 20 minutes and by avoiding the use of cannon nets, as well as being particularly cautious when capturing or handling juveniles.

Academic year: 2011-2012.

Cotín Martínez, Javier

E-mail: falco.columbarius@gmail.com / jcotin@ub.edu

Supervisors: Sanpera Trigueros, C. and de Jover Armengol, L.

Birds as bioindicators of pollution in aquatic and terrestrial environments.

[Las aves como bioindicadoras de contaminación en ambientes acuáticos y terrestres.]

## Abstract:

Birds have been widely used as bioindicators. In this study we face the use of birds

as bioindicators of metal pollution in two different scenarios of contamination: one that takes place in an aquatic environment, the Ebro river basin, and a second that occurs in a terrestrial environment, the Bolivian Andes. In the case of the Ebro river basin, the pollution threat is a factory located at the river bend, close to Flix, that due to its long operational activity and along with the construction of a dam next to the plant around 1960, resulted in the accumulation of 200.000-360.000 tons of industrial wastes in the riverbed, occupying an area 700 long and 60 m width. In this study case we evaluated whether aquatic birds such as the purple heron Ardea purpurea reflect the potential pollutant exposure from Flix reservoir among different riverine and deltaic areas, and assess their usefulness as bioindicators. Also we examined if the polluted wastes of Flix reservoir affect the levels of pollution of the habitats where waterbird populations of the Ebro Delta (situated 90 km downstream) forage and feed. Stable isotopes showed the high nitrification and lower carbon signatures in the river, and together with the niche width metrics, that common and Sandwich tern (Sterna hirundo and S. sandvicensis) behave as strict specialists at the Ebro Delta, with narrow niche widths. In the opposite way, little tern Sternula albrifrons, little egret Egretta garzetta, purple heron, night heron Nycticorax nycti*corax* and the common moorhen *Gallinula* chloropus behave like generalists foragers, with broad niche widths. Mercury levels in nestlings of purple heron at Flix site and eggs of Audouin's Gull Larus audouinii, little tern and common tern at the Ebro Delta are high enough to be of special concern. Arsenic (specially used in combination with carbon signatures) discriminates outstandingly between marine and freshwater species. Both eggs and nestling feathers

of purple herons are adequate bioindicators for trace element pollution, but nestling feathers present certain advantages. The six selected blood parameters (TOSC ROO\*. TOSC OH\*, BhCE, CbE, LDH and MN) provide the first evidence of an association of biological responses with pollutants in heron species. The second study case takes place in Bolivia. Anthropogenic mining has taken place in the Bolivian Andes since at least the fifteenth century. Particularly the East of Oruro Department in the Eastern Andean Cordillera is affected by a long term history of mining. These mining activities were characterized by the deposition of large tailing piles, which accumulated in abandoned and active mines, where trace metals such as lead, arsenic, cadmium, and antimony could reach surface waters and soils, and so the biota. In this case we evaluated the potential of tinamou species as sentinels of exposure to local trace metal pollution and studied different routes of lead accumulation into the sentinel species, in order to assess the usefulness of feather levels as a measure of the exposure to this pollutant. We found that the small home ranges detected in ornate tinamou Nothoprocta ornate (lower than 1 km<sup>2</sup>) and their sedentary habits make of this species an adequate bioindicator of local pollution. We recommend feathers for future monitoring programs as they are a non-invasive sample. Higher rates of histopathological damage were found in kidney at the polluted sites. We detected high levels of trace element at the polluted sites in the two studied species of tinamou (ornate and Darwin tinamou Nothura darwinii), many of them trespassing hazard levels. The calamus is the most suitable section for assessing the original endogenous lead levels in feather samples.

Academic year: 2012-2013.

## Jiménez García, Isadora Christel

E-mail: isadora.jimenez@gmail.com

Supervisors: Ferrer, X., Vieites, D. R. and Certain, G.

Offshore wind energy and birds: integrating assessment tools in space and time.

[Energía eólica marina y aves: integración de herramientas de evaluación en el espacio y en el tiempo.]

## Abstract:

Amongst the available renewable energy sources, offshore wind energy is having a rapid expansion. Renewable energies are viewed as an environmental benign alternative to the energy production based on fossil fuels, but the emerging development of offshore wind energy has also raised public concern over its potential impact on seabird communities. To assess this impact, seabird distribution and abundance maps are usually included in Strategic Environmental Assessments (SEA) and Environmental Impact Assessments (EIA). Nevertheless few studies have attempted to develop analytical methods to assess quantitatively the potential impacts of offshore wind farms on birds based on seabird distribution data. This PhD study aims to contribute to fill in this gap in the methodological approach. The thesis is a compilation of four studies that focus on different analytical approaches that integrate the spatial and temporal dimension of seabird distribution at large, regional and local scale. After presenting these integrative tools the thesis provides practical guidelines for practitioners on how to integrate the tools in the design of SEAs and EIAs. For the SEA at large scale the thesis proposes the use of a sensitivity index to define key development areas. Within these areas, at regional level the same index could be used to define exclusion areas. The first paper of the thesis justifies

changes in the mathematical formulation of a previous index and applies the new index in the Bay of Biscay dataset, showing its improvements. The second paper applies the index to the Iberian Peninsula coasts. At regional scale, once key development areas are identified, the third paper of the thesis presents a new assessment tool based on seabird aggregation in space and time to create a potential risk map. In this map, areas with collision and/or habitat loss risk can be delimited. This method enhances the optimal location of wind farms minimizing the potential impact on the main seabird populations in the region. At local scale, and once a project location is selected, this potential risk map can also be used to point to the necessary studies for EIA or compulsory monitoring once an offshore wind farm is accepted. Finally, the fourth paper shows how the satellite tracking of individuals can be used with flagship species at local scale within an EIA to describe daily spatio-temporal patterns.

Academic year: 2012-2013.

Martínez Benito, María

E-mail: mmartinezb@ub.edu

Supervisors: González-Solís Bou, J. and Becker, P. H.

Avian sex ratio and sex-specific traits in offspring.

[Razón de sexos y atributos sexuales de la descendencia en aves.]

#### Abstract:

Sex allocation (SA) refers to the proportion of resources allocated to male and female reproduction. Relatedly, sex ratio (SR) refers to the numbers of each sex that are produced. Hence, their scientific study deals with the variation in the quantity and quality of males and females and its ultimate and proximate causes. Adaptive theories make predictions about sex allocation under the assumption that facultative adjustment will be favoured when the fitness benefits compensate the fitness costs. However, although SA theory is one of the great successes of evolutionary biology and its mechanisms have been successfully applied to a number of taxa, they are still poorly understood in vertebrates. This thesis investigated causes of variation in sex allocation in birds in general and in common terns Sterna hirundo in particular, with a focus on the role of sexual size dimorphism (SSD) and other features of avian life-history, associated with differences in the reproductive value of sons and daughters. Setting the stage for the studies, the thesis provides a brief historical introduction and a summary of the recent evidence for sex allocation in birds. In the first section, we present the results of tests of a sex ratio population model which involve species with SSD, in which it is possible to estimate the strength of selection for adjustments. We performed both comparative methods and species-level analyses of 83 bird species, demonstrating that hatching and fledging sex ratios are influenced by the degree of SSD. Dimorphic species show a higher proportion of the smaller sex, but the effect is particularly strong in species with female-biased SSD. Parents adjust offspring sex ratio by differential production, possibly the less costly mechanism, rather than by sex-specific mortality. The degree of SSD was also correlated with offspring sex-biased vulnerability (expressed as a greater mortality and mass reduction of the larger sex), as shown by a slightly but significantly elevated vulnerability of the larger sex. The survival and viability costs involved in achieving a larger body size support the size-dependent explanations of vulnerability. However, they should be combined with sex-dependent explanations, as growing large is mainly disadvantageous when coupled with the male-phenotype. Other life-history characteristics of the

species, however, appear as potential modifiers of the relationship between SR and SSD. This reflects the composite matrix of factors that are acting on avian sex ratio evolution. In the second section, the common tern was used as the model species to investigate, via detailed observational and experimental studies, the factors that could shape sex allocation in this slightly dimorphic species. In search for indications of different reproductive value/costs of each sex and possible differential parental allocation, we describe the sexual dimorphism in phenotype and developmental strategies of the offspring, related to environmental and parental traits. Few and only subtle effects were found. Next chapter reports an experimental manipulation of food carotenoids, which differentially affected immunocompetence of male and female chicks, thus demonstrating a potential way of how parents can invest sex-specifically. Thus, these results underline (i) the potential of parents to affect the development of their offspring by differential supply of particularly important resources, such as carotenoids; and (ii) the potential influence of parental reproductive quality on the offspring sexual differences, even if these are slight. Finally, we made use of a complete long-term dataset (7 years) for one particular population of common terns in Wilhelmshaven, Germany, to examine environmental and parental influences on sex ratio and sex-specific mortality. Population patterns revealed no deviations from parity, but environmental factors and parental condition and quality influenced sex ratio adjustment at individual level. Overall, this thesis shows that, in birds, sex ratio deviations from the 1:1 expectation, though plausible and possible mechanistically, are slight in general. It also highlights the intricate relationships between facultative sex ratios and individual and life-history traits which drive the evolution of sex allocation in birds.

Academic year: 2012-2013.

#### Universidad Complutense de Madrid

Cano Alonso, Luis Santiago E-mail: catuche.gallego@gmail.com Supervisor: Tellería Jorge, J.L. Biology and conservation of the black stork *Ciconia nigra* in the Iberian Peninsula. [Biología y conservación de la cigüeña negra Ciconia nigra en la península Ibérica.]

## Abstract:

The black stork Ciconia nigra breeds throughout the Palaearctic and includes populations in the southern tip of Africa. The European population is composed of one large population that ranges from Russia to France and from Baltic countries to Greece and Italy, with one small population in the Iberian Peninsula, isolated at the western corner of the Palaearctic. In the last two decades, the central European black stork population has been largely studied through different studies as well as doctoral thesis. However, the scientific information available on the Iberian population of the black stork is very scarce. This thesis has gathered fragmented and dispersed information on the species in Spain and Portugal from regional environmental departments, naturalists and own data. Additionally, satellite tracking of central European black storks has been also gathered from different institutions in order to explore the potential differences between the migratory journeys, stopovers and wintering areas of Iberian and central European populations of the species. The main purpose of the thesis is to contribute to improve the knowledge of the Iberian population and provide useful information to the managers in charge of the conservation of the species in Iberia. The thesis is split into three main blocks: migratory, wintering and breeding periods. With regard to migration, the Iberian black storks studied show large-scale migration routes similar to other European populations, implying that a significant part of the Iberian population may move to Africa. In the autumn migration, there were some differences in the departure dates from breeding areas. The mean difference (15 days) in the departure dates from the breeding grounds showed marginal differences between populations. The temporal gap was reduced to five days when crossing the Strait of Gibraltar and to seven days in the arrival date to wintering grounds. Black storks moving across the Strait of Gibraltar were distributed on the western side of the Sahel, except one Iberian adult that performed an unexpected track eventually reaching the African wintering quarters typical for the Eastern population of the species. After visual inspection of the patterns, it was explored whether breeding and wintering ranges had a parallel distribution (western populations inhabit the westernmost wintering grounds compared to eastern populations). The results supported segregation between breeding and wintering areas for the study individuals. Focussing on the movements and mortality of the set of satellitetagged Iberian black storks moving to Africa, the results reveal that the mortality of Iberian black storks was strongly related to their fate in Africa, where most of the casualties occurred among the tracked storks. The results also support the remarkable differences between the protected area network affecting this species in Africa and Iberia. It is predicted that less than 5% of the West African range of wintering black storks is protected by reserves, a result that agrees with the pattern depicted for Iberian birds (8.6%). This may explain why most of the Iberian storks lost in the Sahel were outside the reserve network. It may be postulated that, in a context of increasing human pressure on water resources in the Sahel, effective management could be easier in protected areas where additional measures could be established to set aside some sectors for conserving water-dependent wildlife. However, the potential enforcement of effective management guidelines in reserves will leave outside a significant percentage of the wintering range of this species

in Africa. Consequently, current and future action plans for conserving the Iberian black stork population should link efforts with AEWA's Strategic Plan, for instance, to promote the global use of water resources for humans and wildlife in the Sahel. Regarding the wintering period, the wintering Iberian black stork's population is increasing in the last decades. A Species Distribution Model (SDM) is made to forecast species distribution within Iberian framework by combining occurrence data based on rings readings with environmental variables during the winter. The model indicated seven main places that contain habitat of highest suitability for black stork wintering in Iberia: Tagus Estuary, Portuguese southern coast, the Doñana Marshes area and rice fields, Cádiz Bay, Guadalhorce Valley, la Albufera wetland and Ebro Estuary. Only some of these places are current wintering sites for the black stork. These places are the closer to the main autumnal migration axis. According to this result, it is suggested that both environmental and geographical factors explain the current distribution and abundance of growing wintering Iberian black stork population respect to the potential suitable wintering areas provided by the model. The last thesis block, devoted to the breeding period, points out a declining tendency in the average of the number of chicks fledged between 1994-1998 and 2005-2009. Another SDM is made to forecast breeding species distribution within the Iberian framework by combining occurrence data based on nest locations with environmental variables during the spring/summer time. The model revealed that the Iberian breeding population of black stork occupies most of it is potential environmental range except the Subbética and Penibética mountains. The Iberian population is unusual in Europe in that the majority of pairs are cliff-nesting. This permits the analysis of productivity differences in relation to nesting substrate and land management of the species in Spain. The results reveal that nesting substrate does not determine differences in productivity success (mean number of fledged chicks/nest). Only those cliff-nesting pairs that breed in open managed lands have lower productivity than pairs that breed in other conditions.

Academic year: 2012-2013.

Moreno-Opo Díaz-Meco, Rubén

E-mail: rmorenoopo@gmail.com

Supervisors: Margalida Vaca, A. and Tellería Jorge, J. L.

Conservation and management of the foraging and breeding habitat of the cinereous vulture *Aegypius monachus*.

[Conservación y gestión del hábitat de reproducción y de alimentación del buitre negro Aegypius monachus.]

#### Abstract:

The objectives of this thesis were: (i) to achieve a deeper understanding of the relationship between the cinereous vulture Aegypius monachus and its habitat; (ii) to identify the most crucial factors for the settlement of nests of the species, for its breeding success and for the selection of feeding areas and types of food; (iii) to evaluate the effects of certain human activities on breeding and foraging areas; (iv) to determine management measures that mitigate the negative effects of human activities on the cinereous vulture; and (v) to assess the conservation status of the species and the causes of the recent population trends in Spain. Fieldwork took place between 2003 and 2011 in west-central Spain. Specifically, the study of the factors associated with breeding and foraging activities was implemented in Umbría de Alcudia breeding colony (Central Spain), while studies on prey preferences and evaluation of different supplementary feeding procedures were developed in different Special Protected Areas for birds of Extremadura and Castilla-La Mancha. The results showed the importance of forests with large trees and well-developed scrub cover, far from human activities and in

areas of difficult accessibility, for selecting the location of the nests. In addition, high values for these variables, along with a better conservation status of nesting platforms, increase the chances of breeding success of the species. In relation to habitat selection at different locations, the application of different sampling and analysis methods across studies determined the variability contained in the models. Thus, the choice of certain experimental procedures involved greater variance/deviance values within the results: sampling points > sampling polygons, random points within the colony > random points outside the colony, a single year of study > more than one year of study, and a higher proportion of random points in relation to nests > lower proportion of random points in relation to nests. In short, both the choice of sampling protocols and the homogenization of protocols between different studies are important for a proper comparison of species requirements in a global context. In relation to feeding patterns, the cinereous vulture was more abundant when carrion was spread over a large area and in high quantities. These conditions optimize the ingestion of food compared to griffon vultures Gyps fulvus, the most competitive species, especially when food is concentrated at single points and as entire carcasses. In addition, the cinereous vulture selects scattered, small and medium pieces of muscles and tendons. Promotion of these characteristics when providing carrion in supplementary feeding programs can be highly favorable to the cinereous vulture and to other threatened raptors such as the Egyptian vulture Neophron percnopterus or the red kite Milvus milvus. During the breeding period adults attend to inputs of carrion in higher numbers, while the proportion of young and subadult birds at carrion inputs remains stable throughout the breeding cycle. Regarding the home ranges of the cinereous vulture, the location of the identified livestock tags showed a foraging range of 66,732.28 km<sup>2</sup> (maximum convex

polygon, MCP) and, based on a likelihood of presence of 95% (kernel analysis), of 152,290.13 ha. As a result, a novel system for studying foraging areas was implemented, with some methodological differences from techniques used in other similar studies. Logging activities within cinereous vulture breeding areas have negative impacts on breeding success. Specifically, the study of cork exploitation showed that adults left the nest when workers came closer than an average distance of 132 m to the nest, especially when the noise level was high or at mid-level. If under these circumstances the chick was under 40 days of age, the activity occurred during the hottest hours of the day and the presence of workers occurred on consecutive days, the probability of breeding failure increased. Thus, in areas subject to cork exploitation breeding success decreased by 20% and the mortality of chicks in nests tripled. On the other hand, cork exploitation is necessary for the conservation of cork oak forests inhabited by the cinereous vulture and harvesting occurs only every nine years. It is therefore necessary to establish protocols aimed at minimizing disturbances by adjusting some working patterns to defined periods and areas and by reducing the level of noise made by the workers. Regarding the management of supplementary feeding points for avian scavengers, it is necessary to satisfy sanitary conditions that reduce the risk of disease transmission while scavengers meet their feeding requirements regarding availability, quality and occurrence. To meet the above conditions when providing carrion, the implementation of mobile, affordable and easy to install/dismantle perimeter fences may help to prevent entry by non-target species that could act as vectors of disease. The mobile electrified mesh fences are effective in this regard and do not alter natural access to the food of avian scavengers. Finally, the analysis of publications on the cinereous vulture showed that the Spanish population could benefit by increased knowledge about

basic aspects of its ecology and conservation status published in journals of scientific impact. The protection of the species and breeding colonies represented a major milestone in the 1970s to 1990s. The positive trend of the population is correlated with one of its most important food sources, wild ungulates. Otherwise, the major risk factor for the species is lack of appropriate food sources, the alteration in availability and occurrence of livestock carcasses as a result of the European management policies for animal by-products and the ingestion of poisoned baits.

Academic year: 2012-2013.

Pérez-Rodríguez, Antón David

E-mail: anton.perez.rodriguez@gmail.com Supervisor: Pérez-Tris, J.

Biogeography of blood parasites in a model avian host with diverse migratory strategies: the blackcap *Sylvia atricapilla*.

[Biogeografía de los parásitos sanguíneos en un hospedador aviar modelo con diversas estrategias migratorias: la curruca capirotada Sylvia atricapilla.]

## Abstract:

The detrimental effects of the parasites on the fitness of their hosts have made of parasitism one of the major forces driving evolution. There are nevertheless several factors which influence the distribution of parasite diversity and impacts, such as geographical variation of climate and habitat structure, the relative isolation of different geographical areas or the variations associated to seasonality. Knowing them is crucial to foresee and prevent the negative effects that emergent diseases represent in a world under a process of global change. In the present thesis we use the host-parasite model conformed by blackcaps Sylvia atricapilla and their avian haemosporidian blood parasites (genera Plasmodium, Haemoproteus and Leucocytozoon) to test how several sources of environmental variation determine differences in the impact of parasites. We first analysed the diversity

of avian haemosporidians in 37 Iberian blackcap populations, using Partial Least Squares regression to assess the relative importance of a wide array of putative determinants of parasite diversity. We determined that both prevalence and richness of haemosporidians were predominantly related to climate (an effect primarily, but not exclusively, driven by variation in temperature), although topographic features also contributed to explain variation in parasite diversity. Our results show that parasite distribution models, which are usually based on climatic variables alone, can be improved by including other types of predictors. We then used this information to model present-time distribution of the areas of high impact of haemosporidian parasites on Iberian blackcap populations, and to assess how the areas of high influence of these parasites are expected to change by the end of the XXI century, assuming several scenarios of climate change. We discovered that the three parasite genera considered show contrasting geographic patterns of variation in prevalence and richness, in agreement with their ecological constrains. Regardless of the global warming scenario considered, both Haemoproteus and Leucocytozoon will lose areas of high richness and prevalence in the future, whereas Plasmodium is expected to expand its range of high influence. Future parasite impacts are nevertheless prone to be more dependent of locally restricted environmental configurations (instead of following broad-scale trends) as the higher the predicted increase in temperature. To determine the way in which parasites evolve to adjust their life cycles to seasonal variation, we performed a Bayesian estimation of how different transmission strategies (strict summer transmission, extended summer transmission and year round transmission) have evolved throughout the evolutionary history of H. parabelopolskyi, a very diverse blackcap haemosporidian. We discovered that year-round transmitted parasites are always of recent origin and that they did not seem to diversify as much as seasonally transmitted parasites; suggesting that, although such strategy may be ecologically successful at present-time, seasonal transmission may be more stable over evolutionary time. We finally tested how several processes involved in parasite colonization and community assembly have shaped the parasite community of the blackcaps inhabiting the archipelagos of Madeira and the Canary Islands. We discovered that these blackcap populations do not face the strong parasite load encountered by their mainland counterparts, despite the fact that blackcap migration from the continent may directly transport mainland blackcap parasites to the islands. These results support the idea that normal hostparasite associations are compromised on islands, and that parasite island syndromes (low richness, frequent host-switching, and reduced specialization) evolve already at early stages of the insular colonization process.

Academic year: 2012-2013.

## Universidad de Málaga

Muñoz Gallego, Antonio Román Supervisor: Real Giménez, R.

Distribution models for Bonelli's eagle Aquila fasciata at different spatio-temporal scales. Implications for management and conservation. [Modelos de distribución para el águila perdicera Aquila fasciata a diferentes escalas espacio-temporales. Implicaciones en su gestión y conservación.]

#### Abstract:

This thesis highlighted that species distribution modeling is not only central to both fundamental and applied research in biogeography, but also to studies of conservation biology, ecology, and wildlife management. The obtained models permitted estimation of species' ecological requirements, although the extent to which causal relationships between species distributions and the predictor variables were unveiled depended on the adequacy of the predictors used for model building and also on the quality of the distribution data used. A modeling method based on logistic regression was used, which has been demonstrated to be a powerful tool that produces robust models, and is broadly used in the predictive modeling of species' distributions starting from presence/absence data. Since classification success using logistic regression is sensitive to the relative proportion of presences and absences in the sample, and the prevalence of Bonelli's eagle was always different from 0.5, we used the favorability function, whose results are not affected by an unequal proportion of presences and absences. This point opens the door to applying fuzzy logic to species distribution models, with conceptual and operational consequences that were particularly important when contemplating the possibility of evolution in the forecasting of future distribution of the species in climate change scenarios. From the estimation of potential Bonelli's eagle's distribution and the specification of how much of the variation of the models was explained by each of the considered factor the implications of this thesis have extended from biogeography to diverse areas of research such as conservation biology and the study of potential impacts of climate change. The implications of what at first glance could be viewed as a mere mathematical modification (the use of favorability instead of probability or suitability values) make ecological sense when a direct and significant relationship between presence-absence data, favorability values and upper limit of local abundance is shown. Once demonstrated that the results of our models, from presence-absence data, provide useful information on spatial patterns of abundance, the implications of the results obtained in the different chapters of the thesis can be a significant advance in the field of conservation biology.

Academic year: 2012-2013.

# Universidad de Navarra

# Vilches Morales, Antonio

E-mail: antvilches@gmail.com Supervisors: Miranda, R. and Arizaga, J. Trophic ecology and habitat selection of common kingfisher *Alcedo atthis* L. in Navarra. *[Ecología trófica y selección de hábitat del martín pescador* Alcedo atthis L. 1758 en Navarra.]

# Abstract:

The common kingfisher Alcedo atthis L. 1758 is a fish-eating bird which is associated with freshwater bodies in well conserved conditions. Currently, there is a negative trend in their European populations, so it is included in the threatened lists of species. As a piscivorous bird, its conservation may conflict with the commercial, recreational or conservation interest of their prey species. To date, the work on this bird species is scarce and many of its trophic ecological aspects remain unclear. The present PhD is composed of a number of chapters which aims to clarify these issues and to define the most important factors in the selection of habitat. In order to do that, we established a series of partial objectives summarized in the following points: (i) determine the relative importance of biotic (food availability) and abiotic (habitat structure and quality) factors on the presence of the species during breeding (chapter 1); (ii) develop a useful methodology to determine the diet of the species from partial examination of pellets found in the nests (chapter 2); (iii) describe the diet and determine, based on food availability, its fishing strategy (opportunistic or selective) (chapters 3, 4 and 5); and (iv) determine the impact of the common kingfisher on a fish species, the Atlantic salmon, with both commercial and conservation interest (chapter 6). The main conclusions of this PhD are: (i) food availability is not significant in the selection of the breeding territories in the rivers of the northern half of

Navarra, although kingfishers tend to settle in sections with higher concentration of dissolved oxygen, less depth and fewer artificial structures in the river: (ii) a review of 130 diagnostic bones is enough to estimate the composition of the diet with a reliability of 95%; (iii) the cyprinidae family makes up the bulk of kingfisher's diet (94%), with the minnow Phoxinus bigerri Kottelat, 2007 being the most consumed species of all; (iv) the feeding strategy during the breeding period has been revealed as opportunistic, consuming preferably the more accessible prey; (v) although there is a preferred intake size ranging between 50 and 60 mm, there are differences according to both the ecological and biological characteristics of the prey species; (vi) there is no selection of prey for feeding chicks, according to a higher energy content; and (vii) a study of the capture rate of Atlantic salmon in the River Frome (southern England) revealed that this fish species accounts for less than 5% of kingfishers' diet and less than 0.8% of the population of salmon in this river.

Academic year: 2012-2013.

# Universidad de Sevilla

Arroyo Solís, Aída

E-mail: aidaarroyo@us.es

Supervisors: Castillo Segura, J. M., Slabbekoorn, H. and Figueroa Clemente, M. E.

Effects of human disturbance on urban birds. *[Efectos de la perturbación antrópica en las aves urbanas.]* 

# Abstract:

Cities are one of the developed landscapes most affected by human disturbance, with large consequences for the behaviour, distribution and densities of animals. In this context, it is critical to determine which are the main disturbance factors decreasing wildlife species richness and ecological diversity in urban areas, and to assess which traits predict species' response to urbanisation. Understanding the responses of animals, and especially birds, to urban disturbances is the first step to develop adequate strategies in the planning and management processes of urban areas. One of the most prominent factors of urban disturbance is related to the dense road traffic, and especially to the noise pollution derived from it, which can result in avoidance behaviour associated with direct stress, but also with interference of acoustic signals that use many animal species to communicate. In fact, a growing number of studies carried out in urban areas are showing a negative effect of traffic noise in the distribution and the population levels of some bird species. Nevertheless, cities are often quite heterogeneous, holding areas where disturbances are less intense and fauna can cope more easily, such as the green spaces remaining after the urbanisation process, which can become very important for the conservation of at least some of the original biodiversity. The overall objective of this PhD thesis was to deepen the knowledge concerning the influence of human disturbances, and especially traffic noise, on urban birdlife. We aimed to improve the insight regarding birds inhabiting urban areas and to understand the true role of urban green spaces as species reservoirs in cities, researching the relationships of parks and public gardens with their external and internal human disturbances. Further, we provide more insight into the relationship between traffic noise and bird distribution and behaviour in urban areas, and we offer tools for making urban green spaces more environmentally suitable for birds. The findings in five different chapters show that anthropogenic disturbance, traffic noise in particular, is really important in influencing bird species distributions, species persistence in green spaces of the city, and breeding behaviour inside parks. Likewise, the data show associations between song features of breeding species and traffic noise altering their distributions and causing behavioural adjustments. Observational and experimental data of the current PhD thesis reveal insights that are contributing to progress in fundamental science but that are at the same time yielding practical tools for city planner policy makers and serving as a basis and/or inspiration to future students.

Academic year: 2011-2012.

Méndez Camarena, María

E-mail: maritxu.mendez@gmail.com

Supervisors: Godoy López, J. A. and Tella Escobedo, J. L.

Fragmentation effects on Dupont's lark Chersophilus duponti conservation genetics. [Efectos de la fragmentación en la genética de la conservación de la alondra ricotí Chersophilus duponti./

#### Abstract:

Human induced land use changes often reduce the size of populations and increase their isolation to limits where an increased susceptibility to stochastic factors may precipitate their extinction. Loss of genetic diversity, accumulation of genetic load and increased rates of inbreeding may reduce birth and increase death rates in small populations. This effect and the loss of adaptive potential have been shown to significantly increase extinction probabilities. Two main micro-evolutionary processes influence genetic patterns in declining and fragmented populations: genetic drift and gene flow. These processes are determined by local population size and inter-patch connectivity. While genetic drift causes random fluctuations of allelic frequencies and loss of genetic diversity through time, dispersal-mediated gene flow can buffer these effects in local populations. The outcome of these two processes is easy to predict under simplified equilibrium models, or pure drift models. This is, however, not the case under the non-equilibrium situation imposed by the recent or on-going fragmentation of wildlife populations, where gene flow

Those markers were tested in populations

of Dupont's, crested Galerida cristata and

thekla lark Galerida theklae and did not

show Hardy-Weinberg disequilibrium, null

alleles or allelic drop-out, and showed dif-

ferences in genetic diversity, inbreeding and

differentiation. An integrated analysis of ge-

netic patterns in the remaining Spanish popu-

lations and the two closest North African

and local drift may vary over time and among patches. Within this framework we focus on the genetic consequences of habitat fragmentation in an endangered species, Dupont's lark Chersophilus duponti. Dupont's lark is the most dramatic example among steppe birds. Despite being among the most valuable and endangered habitats in Europe, steppes are considered as unproductive and unattractive because of its low economic profitability. Large steppe areas are being transformed into agricultural lands since the last half of the 20<sup>th</sup> century. Consequently Dupont's lark distribution has been reduced to North Africa and some scattered populations embedded in an unsuitable landscape matrix in Spain. This process of steppe conversion has been extensive and fast enough to drive several populations to extinction in recent years. Low population numbers and negative population trends have promoted the uplisting of Dupont's lark to "Endangered" in the Spanish Red List and "Near Threatened" in the IUCN Red List. Our aim in this thesis is to identify the genetic consequences of human induced land transformations in Dupont's lark populations examined at different spatial scales and establish management recommendations for Dupont's lark. To gauge our objective, we took first into account the long-term effects of biogeography, historical climatic events or evolutionary forces that influence the contemporary genetic structure. We analysed the historical signal of genetic structure between Iberian Peninsula and Morocco. Our results suggest that Morocco and Iberian lineages split from an older one probably when Iberia became isolated from North Africa. Those lineages form two reciprocally monophyletic groups indicating an absence of gene flow due to the Mediterranean Sea barrier. Our analyses did not detect subdivisions within Iberian even among previously identified ecogeographical regions. Then, we developed twenty microsatellite markers to understand the contemporary genetic patterns at Iberian scale.

ones confirmed that recent habitat fragmentation is isolating Spanish populations. We found that the ancestral panmictic population is evolving into several different units in the absence of gene flow and under genetic drift. Moreover, genetic differentiation is also acting within populations. Therefore, we evaluate the effects of population size, isolation and their interaction on the genetic patterns throughout an information-theoretic approach to model selection. This proxy allowed us to address the importance of interactions among habitat variables, an aspect seldom considered in fragmentation studies, and defined fragmentation thresholds below which genetic erosion becomes apparent. Genetic diversity and inbreeding were influenced by the size of local populations depending on their degree of isolation, and genetic differentiation was positively related to isolation. In last term, in a smaller spatial scale at the Ebro Valley, we evaluated the effect of patch and matrix characteristics. Patch size and non-irrigated arable land surrounding the breeding habitat patches were positively related to genetic diversity, and negatively to differentiation. Moreover, the interaction between intensive agricultural land and the distance to the nearest population showed a clearly negative effect on inbreeding and diversity. In this thesis, we conclude that due to their long-term isolation, European and North African populations should be treated as distinct Evolutionary Significant Units and European populations supports their management as a Single Conservation Unit. The spatial genetic structure, significant levels of inbreeding and high relatedness within patches and the action of genetic drift raise concerns on the viability of most of the extant populations. We therefore highlight the urgency for steppe patches to be protected, expanded and reconnected. Translocations could be considered as a complementary, faster management action to attenuate the crowding and genetic effects of population fragmentation without compromising the current local adaptations, culture diversity and genetic clusters. We also identified a minimum local population size of 16 male territories and a maximum distance of 30 km to the nearest population as thresholds below which genetic erosion becomes apparent. Indeed, our results alert on possibly misleading conclusions and suboptimal management recommendations when only additive ecological effects are taken into account. Finally, we strongly recommend supporting traditional agriculture and grazing practices surrounding the breeding habitat patches to increment gene flow in Dupont's larks populations. Other strict-steppe dependent birds as well as those associated to pseudo-steppe agricultural landscapes would benefit from these management recommendations.

Academic year: 2011-2012.

#### Rodríguez Martín, Airam

E-mail: airamrguez@ebd.csic.es

Supervisors: Negro Balmaseda, J. J. and Alcaide Torres, M.

Migratory strategies of the lesser kestrel *Falco naumanni*: determining wintering areas and condition for migration.

[Estrategias migratorias del cernícalo primilla Falco naumanni: determinación de las áreas de invernada y de la condición para la migración.]

#### Abstract:

Despite the lesser kestrel *Falco naumanni* is one of the most studied raptors in Europe, the origin of the wintering populations in Africa was unknown. Thus, the main aim of

this thesis was to provide basic information on the lesser kestrel migratory connectivity between breeding and wintering areas, using intrinsic (genetic) and extrinsic (geolocators) markers. For first time in raptors, we used geolocators to determine wintering areas of the western breeding population (Huelva province, southern Spain). We found that the kestrels wintered in the vicinity of the rivers Senegal and Senegalese Saloum, western Africa. Geolocators showed no adverse effects in tracked adults. The return rate was similar to that observed in other years and colonies (15 out of 20 birds sampled in 2007 returned in 2008) and the weight of tracked individuals did not differ from control birds at the time of recapture. Breeding parameters (clutch size and number of fledglings) were not affected by geolocators. Moreover, we used a noninvasive approach based on a genetic marker, the major histocompatibility complex (MHC), to infer the origin of individuals wintering in the most important areas for the species. To do this, we employed the information on the population structure of MHC class II B genes in the breeding range and collected molted feathers at large roosts in Senegal and South Africa. The tips and blood clots of feathers were used as a source of DNA. A high proportion of private alleles from the western breeding range in Senegal indicated a strong connectivity between Europe and West Africa. Kestrels wintering in South Africa were genetically different from Europeans, suggesting that South Africans roosts are composed by Asian birds. Finally, we looked for sources of variation of nutritional biochemical parameters (i.e. triglycerides, cholesterol, uric acid and urea) of both nestlings and adults. Reference values indicated that, as a rule, lesser kestrel showed more elevated triglycerides, urea and uric acid levels than other raptors. All analyzed factors except gender (i.e. year, colony, sampling time, presence/absence of a geolocator, body mass, laying date and capture date) reached significance for at least

one biochemical parameter. The most influential factor was sampling time, which leads to an important postprandial increase in the concentration of all biochemical parameters in nestlings, and uric acid and urea levels in adults. After this thesis, it seems clear that western and eastern breeding populations winter in different areas in Africa. So European lesser kestrels winter in the Sahel, while Asian birds winter in South Africa. Furthermore, we demonstrated that plasma metabolites differ with respect to other raptors, possibly as a result of their feeding and hunting habits.

Academic year: 2011-2012.

#### University of Valladolid

Chiarati, Elisa

E-mail: elisachiarati@libero.it

Supervisors: Baglione, V. and Canestrari, D. Social relationships and group formation in cooperatively breeding carrion crows *Corvus corone corone*.

[Relaciones sociales y formación de grupos con reproducción cooperativa en la corneja negra Corvus corone corone).]

# Abstract:

Cooperatively breeding societies are characterized by individuals providing care to young that are not their offspring. Natal delayed dispersal is typically a prerequisite for cooperative behaviour in birds, because helpers are often offspring that remain in the natal territory past the age of independence and aid their parents in rearing new siblings. The evolutionary explanation of cooperative breeding therefore lies in identifying factors influencing offspring delayed dispersal and their subsequent decision to help at the nest. The hypothesis of "parental facilitation" or "nepotism" suggests that offspring delay dispersal because of the benefits obtained from the prolonged association

with their parents through, for example, preferential access to the resources of the territory and/or defence against predators. Regarding helping behaviour, the "pay to stay" hypothesis proposes that it represents a 'rent' that subordinates pay to the dominants in order to be tolerated in their territory. This implies that dominant breeders should 'punish' helpers that do not provide sufficient help, or, as recently suggested, that lazy helpers should prevent punishment by displaying submissive behaviours. This thesis analysed both hypotheses by studying the social dynamics in cooperatively breeding groups of carrion crows during the access to an experimental food source. Social groups comprised two types of helpers at the nest, namely offspring of the breeding pair, which can stay on the natal territory for up to four years and immigrants. Results showed that the access to food was regulated by linear dominance hierarchies that remained stable through the breeding season and over the years. Breeding males were always at the top of the hierarchy, followed by male immigrants and male offspring, which were dominant over all the females in their group. According to the hypothesis of nepotism, dominant breeding males provided their offspring with a preferential access to food resources of the territory by (i) attacking male immigrants with more frequency and intensity than offspring, and (ii) associating preferentially with their offspring on the feeding spot and sharing food with them. This parental facilitation allowed the offspring to spend more time feeding than higher-rank immigrants. Moreover, breeding males were fast approaching a novel food resource, followed by male immigrants, whereas retained offspring and breeding females were last. Results showed that this order, which matched the dominance ranks, was unlikely to be enforced through social interference but derived from differences in individual level of neophobia among group

members. In groups that were simultaneously presented with two identical novel food sources that could not be monopolized by one individual, subordinates only used the one that was first explored by the dominant male. This indicates that the explorative behaviour of the dominant breeding male provided cues that helped subordinates to overcome their neophobia. Therefore, retained offspring may benefit from living in families with their nepotistic father by gaining access to food without incurring the risk of exploring. Finally, I found no evidences of 'pay to stay' in cooperative groups. Contrarily to predictions, neither the aggressive behaviour of the dominant breeding males nor the submissive behaviour of helpers (retained offspring/immigrants) correlated with the level

of contribution at the nest of the latter. Instead, at the end of the breeding season, dominant breeding males reduced significantly their aggressions towards immigrant males, who reduced the frequency of submissive behaviours accordingly and increased the time spent foraging together with the dominant males, whereas alpha male/offspring relationships did not change over time. I suggest that the seemingly lack of 'pay to stay' in crows arises because of the important insurance function of 'lazy' helpers, which can fully compensates for a sudden reduction in the provisioning effort of the group, avoiding a decrease in reproductive success during unfavourable circumstances.

Academic year: 2011-2012.