

Special Review

PhD dissertation review in ornithology (fourth edition)

Avocetta collects and periodically publishes PhD thesis defended by Italian students either in Italian or foreign universities. Italian ornithologists who carried out their PhD in the last year, both in Italy and abroad, are invited to contribute to this column by sending an abstract of their thesis to submissions@avocetta.org. For further information see <https://www.avocetta.org/review-of-phd-dissertations/>.

Edited by Letizia Campioni

letizia.campioni@avocetta.org

 0000-0002-6319-6931

Introductory note

This is the fourth PhD-thesis collection in the ornithological research that Avocetta is glad to present to its readers. Compared to the previous reviews, this time there is a novelty! We extended our collection by including the theses of Italian ornithologists who chose to carry out their PhD abroad or in collaboration with foreign institutions. In fact, over the last decades, the number of Italian students (of all disciplines) who preferred an international PhD programme has been growing due to the availability of EU funded scholarships and the explicit recognition, by the National Research Program, that international mobility and training experience abroad is fundamental during PhD studies and for professional development (Tocchioni & Petrucci 2020).

This PhD-thesis collection aims to offer an overview on the diversity of the research lines that exists in ornithology (both in Italy and Europe) and on the advances that have been made by young researchers through the completion of their thesis. We collected and reviewed the theses defended between the 2017/2018 and 2019/2020 academic years in European and Italian Universities by contacting colleagues, students and by using the social media to spread the voice. As already stated in the previous reviews, despite some thesis may have been passed overlooked to this review, it is evident how a large

proportion (50%) of the reviewed ones has been defended in foreign universities. This figure is encouraging as it shows that Italian university and the ornithological community are able to stimulate and make students passionate about ornithological questions. Nevertheless, it highlights how many of these students choose to move abroad to carry out their PhD. This trend may suggest that Italian university are not able to adequately respond to the demand of all students nor to attract foreign students to compensate for who leave the country. Moreover, the total number of theses we compiled from 2013/2014 up to now (eight academic years) adds up to merely 24. Should we look at this number as an “alarm bell” for the Italian ornithological community? Likely we should, because in the long run, ornithologists may see its representation in academia critically reduced. To maintain the Italian ornithological research viable, and to adapt to this changing scenario where student mobility through European programme is highly encourage, it would be important for the Italian researchers to strength their collaborations with foreign institutions/researchers. Before presenting the main ornithological topics covered by the theses, it is worth noting that the valuable work done by these young ornithologists and the relevance of their results have already been recognised by the scientific community. Indeed, around 23 research papers (extracted from the

theses) have been already published on peer reviewed international journals of broad ecological interest (see the reference list at the end of the review). Finally, we want to highlight that in the present PhD-student group there is an unbalanced man:woman sex ratio (5:1) suggesting how ornithology is not exception to the overall and well-known gender biases that exist in science (Penner 2015).

Overall, the thesis reviewed in this collection cover topics related to different aspects of migration ecology (3 theses), climate change and conservation (2), vocal communication and function of signalling (1) and behavioural strategies and learning in social groups (1). The theses present results based on field-collected data (including the use of remote tracking telemetry) as well as on experiments carried out in aviary. The theses are presented in order according to the academic year and alphabetic order of the PhD candidate surname. Last note, the content of the abstracts has not been reviewed, hence the authors are accountable for it.

Thesis 1

Vocal communication in zebra finches: a focused description of pair vocal activity

Author: **Pietro Bruno D'Amelio**, pie.damelio@gmail.com

Supervisor: Prof. Manfred Gahr, Dott. Andries ter Maat, Dott. Lisa Trost (Max-Planck-Institut für Ornithologie, Seewiesen Germany).

Academic Year: 2017/2018, Ludwig-Maximilians-Universität München, Germany.

Abstract

Vocal communication is the primary mode of signalling in a wide variety of species and commonly plays a decisive role in reproduction and survival of both the sender and the receiver. In birds, vocal signals have evolved to be astonishingly diverse, with thousands of different vocalizations used for highly disparate functions. Some vocalizations are loud and broadcast to reach the greatest possible number

of receivers; others are barely audible and directed to a specific individual, often a mate. The function of each element of a bird's vocal repertoire is not always simple to interpret and the same signal can have multiple functions. To understand the role and influence of each vocal signal of a species, and thus the principles of vocal communication, we need to precisely quantify not only each sender vocalization, but also the context of its emission. In my thesis, I used the zebra Finch (*Taeniopygia guttata*) as a model species to study the vocal communication of birds. I focused on pair communication as the smallest functional unit of a group. I considered all the vocal signals emitted but I focused my attention on the calls: of which thousands are emitted daily. These vocalizations are unlearned, very soft (low amplitude), very short (>100 milliseconds) and very similar among different individuals. Therefore, my colleagues and I developed and evaluated a method to individually record small animals (chapter 1). I describe a device, miniaturized backpack microphones, able to record birds singularly and the tools needed to record several individuals synchronously. This tool can be employed in many experimental settings to quantify the vocal behaviour of multiple individuals with only a transient effect on their behaviour and capable of capturing the softest of their vocalizations. I first used this tool to verify that birds were able to tell who was calling (chapter 2). I found that even the short unlearned calls have an individual vocal signature and birds are particularly eager to answer their mate's vocalizations. Then, I studied the development of, and signals used within pair communication (chapter 3). I described in detail the timed vocal exchanges of paired zebra finches; I observed that their antiphonal calling resembled duets. Moreover, I found that pair communication develops along with pair formation, so that by the time the pair is formed the number of calls used to answer each other is similar between partners. Finally, I aimed to discover when the calling interactions were taking place to have insights into the functions of these short, soft, unlearned vocalizations of zebra finches. To do so, I assembled

a simple method to track automatically the position of the birds while recording their vocalizations. I was then able to describe how the relative positions of partners within a pair influenced the probability of calling (chapter 4), which revealed the precise meaning of a specific vocalization. This experiment also shows the accuracy and precision of our behavioural quantification, marking an important step towards new methods to automatically generate ethograms. Altogether, my dissertation contributes to our understanding of bird vocalization by determining that the continuous calling of zebra finches is not just “a soft background hum”, but rather the foundation of organized vocal networks.

Thesis 2

The role of environmental factors on the spatial behaviour of three long-distance migratory species

Author: **Giulia Cerritelli**, giuliacerritelli@hotmail.it

Supervisors: Prof. Paolo Luschi, Dott. Dimitri Giunchi (Università di Pisa, Italy).

Academic Year: 2018/2019, Università di Pisa, Italy.

Abstract

Many vertebrate species embark in migratory movements to make the most of the available resources and are guided by internal and external stimuli in their choices. During my PhD, I aimed at evaluating the role of external factors on the spatial behaviour of European teal (*Anas crecca*) and sea turtles (*Caretta caretta* and *Chelonia mydas*), all satellite tracked during long-distance migrations. Most of the tracked teal left their wintering grounds located in three different Italian sites between mid-February/March following a direct route along the Black Sea-Mediterranean flyway and reaching breeding sites located in North-Eastern Europe in May. Along their migratory route most birds stopped for several weeks at stopover sites, especially at the very beginning of migration, and this led to a slow overall migratory speed. The characterization of teal migratory phenology was crucial to subsequently

assess the effect of temperatures and winds experienced on the bird's decision to leave their wintering area and longest stopover site frequented. The results showed that only the progressive increase of daylight hours triggered teal to leave their wintering ground, while, once migration had started, birds took into consideration only experienced temperatures to continue their migration, totally disregarding daylength. Winds experienced before departure, on the other hand, did not seem to play a role in teal's decision to leave or not an area. In the second part of my work, I investigated the effect of sea currents on turtles during their open-sea migrations and the navigational strategies they may rely on. I firstly performed a vector subtraction between the satellite-derived and sea currents velocities to assess the turtle's active contribution to the overall movement. The results obtained showed how the effect of currents was variable and linked to the area considered, further highlighting the importance of carefully evaluate sea currents when studying turtle movements from tracking data. Finally, I used individual based models to simulate with different navigational strategies the oceanic migrations of green turtles. From the comparisons between modelled routes and turtle tracks, it was evident that a simple navigational mechanism (follow just one direction throughout open-sea crossing) would allow turtles to successfully reach a wide target, but a more complex system like true navigation was indeed required when the goal to reach was small and isolated. This suggests that also in turtles there might be a coexistence of different navigational mechanisms used to accomplish different orientation tasks.

Thesis 3

Alpine birds and climate change

Author: **Davide Scridel**, davide.scridel01@universitadipavia.it

Supervisors: Prof. Giuseppe Bogliani (University of Pavia, Italy), Dr. Paolo Pedrini (Museum of Sciences

– MUSE, Italy), Dr. Mattia Brambilla (Fondazione Lombardia per l'Ambiente – FLA, Italy).

Academic Year: 2018/2019, Università di Pavia, Italy.

Abstract

Although considered globally important areas for biodiversity, mountain regions remain poorly studied despite their renowned susceptibility to climatic alterations. In this thesis, we reviewed evidence for impacts of climate change on Holarctic mountain birds in terms of physiology, phenology, trophic interactions, demography and observed/projected distribution shifts, including effects of other factors that interact with climate change. We identified 2,316 bird species breeding in the Holarctic, 818 of which were defined as either high-elevation mountain specialists ($n = 324$) or mountain generalists ($n = 494$). We found evidence of biological and ecological responses of mountain birds to climate and environmental change, but little is known about underlying mechanisms or synergistic effects. Meta-analyses did not find a consistent direction in elevation change to track suitable climate but suggested that in the future mountain birds will be significantly more impacted than non-mountain species. In Italy, we found a strong positive correlation between change in range size and species thermal index confirming that recent climatic warming has favoured species of warmer climates and adversely affected species occupying colder areas. Using the white-winged snowfinch *Montifringilla nivalis* (a mountain indicator species sensitive to climate change) as a model species, we showed that annual apparent survival of females was negatively correlated with warm and dry summers. We also found that snowfinches selected climate sensitive microhabitat during the nestling rearing period: cool sites with short grass cover, melting snow margins adjacent to grassland and snow patches. These microhabitats harboured high quality and quantities of invertebrates and snowfinches were able to efficiently tune their microhabitat selection in relation to prey abundance and type, suggesting a high adaptability to resource variation in species and

time, a typical characteristic of high elevation sites. When hindcasting (1976) and forecasting (2066) the suitability of such microhabitats in relation to the observed changes associated to climate change, we found higher suitability in the past and a predicted decline in the future. Grazing activities could improve the suitability in the present and in the future, but only for snowfinch populations that can have access to grassland areas. Measures for mountain bird adaptation to climate change mostly relied on broad-scale management and extension of protected areas for species already present and for future colonizers from lower elevations. We suggested the development of restoration plans that consider threats and opportunities resulting from interactions of climate and land-use changes and encompass different spatial scales, from landscape to microhabitats.

Thesis 4

The effects of environmental conditions on soaring migratory birds crossing the Mediterranean basin

Author: **Paolo Becciu**, pbecciu89@gmail.com

Supervisor: Prof. Nir Sapir (Animal Flight Laboratory, Department of Evolutionary and Environmental Biology, and Institute of Evolution, University of Haifa, Haifa, Israel).

Academic Year: 2019/2020, University of Haifa, Israel.

Abstract

Flying animals are affected by various factors during their migration journey, and the study of animal movement by radars and GPS loggers has been instrumental in revealing key influences of the environment on flight behaviour and route selection. For instance, wind is of utmost importance for flying animals as wind speed and direction may strongly affect the animal's flight speed and energetics. Specifically, for migratory birds, tailwinds were found to initiate flight and facilitate higher migration intensity and faster migratory movement while lowering the energetic cost of flight. Furthermore, studying

the causes and consequences of route selection in animal migration is important for understanding the evolution of migratory systems and how they are affected by environmental factors at various spatial and temporal scales. This thesis integrates information on the effects of environmental factors, and specifically meteorological conditions, geographic features and anthropogenic developments, to substantially advance the understanding of the ways by which flying animals are affected by, and respond to, their dynamic aerial habitat and the complexity of the landscape over which they move. The thesis includes three chapters, all of which have been published as papers in peer-reviewed ecological journals. These studies demonstrate the flexibility of flight behaviour and movement of flying animals in response to environmental conditions. My work highlights that soaring migrants show high degree of flexibility in their behavioural responses according to geographic features they encounter during their journeys and the dynamic atmosphere within which they fly. My work proposes that route selection and flight performance at relatively small spatiotemporal scales can have different outcomes depending on several external and internal parameters, such as geographic features, wind speed and direction, age, migration time along the season and migration season (spring or autumn). Furthermore, my work suggests that changes in atmospheric conditions that result from global climate trends may directly impact migrating animals. Specifically, changes in wind regimes in the area of the Iskenderun Bay (Turkey) that are linked to the ongoing global warming could have dramatic influence on the storks that migrate through this area. More research on this topic that includes additional species and wider spatiotemporal scales will assist the generalization of my results and will facilitate better exploration of their implications.

Thesis 5

How to recover after a long flight: Energy management at stopover sites in migratory birds

Author: **Andrea Ferretti**, andrea.ferretti1989@gmail.com

Supervisors: Prof. Leonida Fusani (Department of Behavioural and Cognitive Biology, University of Vienna and Konrad-Lorenz Institute of Ethology, University of Veterinary Medicine, Austria), Prof. Thomas Ruf Research Institute of Wildlife Ecology, Department of Interdisciplinary Life Sciences, University of Veterinary Medicine, Austria).

Academic Year: 2019/2020, University of Vienna, Austria.

Abstract

Billions of migratory songbirds fly long distances twice a year alternating nocturnal flights with stopovers to rest and recover energy. Time is one of the main constraints for nocturnal migratory birds. The need to arrive first at the breeding ground leads birds to minimize time spent at stopover sites through the optimization of energy recovery. At the stopover site, migratory birds must face their two opposite needs: sleep and restore energy reserves rapidly. Although several studies have extensively investigated factors affecting stopover duration, only few focused on behavioural and physiological strategies required to manage energy reserves. The goal of my PhD project was to investigate how birds manage their energy reserves during stopover, focusing on the modulation of two fundamental behaviours: foraging and sleep. My project was divided into three studies. In the first study, I investigated the influence of food availability, a marker of site quality, and food intake on diurnal locomotor activity of lean migratory birds. In the second study, I investigated the relationship between markers of physiological condition - the extent of energy reserves and oxidative status - on sleep and food intake. Finally, in the third study I investigated the relationships between the physiological condition and the posture displayed during sleep. Our results showed that site quality modulates the energy invested in food searching by lean individuals during stopover. Indeed, beside their limitations in food intake, birds in poor conditions reduce diurnal

locomotor activity according to food availability. Moreover, I revealed a new, important role for sleep in energy management during migration. Although differences in the migratory strategies may result in different regulation of sleep, I showed that the amount of energy reserves is the main determinant for sleep posture choice across species: lean birds preserve their energy reserves by sleeping with the head tucked in the feathers, a posture that allows to reduce the metabolic rate. However, this posture reduces the speed of reaction to potential predators and is therefore avoided by birds in good conditions. Overall, this series of studies adds important information about stopover behaviour and its modulation to manage energy reserves in migratory birds and provide novel prospective on the role of sleep in energy management.

Thesis 6

From individuals to groups and back: interactions between individual variation in behaviour and group performances in house sparrow

Author: **Beniamino Tuliozi**, beniamino.tuliozi@gmail.com

Supervisor: Matteo Griggio (Università degli Studi di Padova, Italy)

Academic Year: 2019/2020, Università degli Studi di Padova, Italy.

Abstract

Differences in behavioural responses are a well-known feature of animal diversity. Distinct strategies coexist within a social group and this variation plays a role in resource exploitation, social learning and various collective behaviours. While there are various theoretical analyses focusing on systems where individual variation and group environment influence each other and interact through feedbacks, assumptions and effects hypothesized by these studies have rarely been studied in controlled conditions. My aim during the PhD was to test if the interactions between variation in behavioural

strategies and the social environment might have an effect on the performance of single individuals within the group and of the group itself. I approached the issue by performing a series of experiments on a captive population of house sparrows (*Passer domesticus*). I started by investigating if social connections between individuals within a group might have an influence on benefits obtained by its members (1: Tóth et al., 2017). I then questioned if previous familiarity with a companion might affect exploration of a novel environment, or if the presence of any conspecific would allow social facilitation (2: Tuliozi et al., 2018). I then assessed the performances of flocks facing each other over limited resources (3: Ligorio et al., 2020). For my penultimate study I focused on the leader/follower dynamic, investigating this dichotomous strategy both during exploration and during a simulated predator attack (4: Tuliozi et al., 2020). Finally, I examined the effect of predation on a proxy for life-history traits, i.e. relative telomere length, and the connection of the latter to several behavioural traits (5). Results showed, respectively, that (1) social connections affected the rate of discovery of a novel food source. (2) The presence of a companion (notwithstanding its familiarity) increased exploratory behaviour in male house sparrows; females on the other hand explored faster only if their companion was familiar. (3) Group membership affected individual performance during a confrontation. (4) Individuals that led movements during exploration were followers during a simulated attack and vice versa, showing that such positions can be context dependent. (5) We found no influence of predation on telomere dynamics: relative telomere lengths however showed changes with successive samples. Our results underlined how assumptions on the potential role of complex feedbacks between individual traits and the performance of the entire group were mostly correct and triable in a controlled setting. In the future, when investigating how animals trade off costs and benefits it will be fundamental to account for the role of diversity within the social environment.

REFERENCES

- Becciu P., Menz M.H.M., Aurbach A., Cabrera-Cruz S.A., Wainwright C.E., Scacco M., Ciach M., Pettersson L.B., Maggini I., Arroyo G.M., Buler J.J., Reynolds D.R. & Sapir N., 2019. Environmental effects on flying migrants revealed by radar. *Ecography* 42: 942-955. doi: 10.1111/ecog.03995
- Becciu P., Panuccio M., Catoni C., Dell’Omo G. & Sapir N., 2018. Contrasting aspects of tailwinds and asymmetrical response to crosswinds in soaring migrants. *Behav. Ecol. Sociobiol.* 72: 28. doi: 10.1007/s00265-018-2447-0
- Becciu P., Rotics S., Horvitz N., Kaatz M., Fiedler W., Zurell D., Flack A., Jeltsch F., Wikelski M., Nathan R. & Sapir N., 2020. Causes and consequences of facultative sea crossing in a soaring migrant. *Funct. Ecol.* 34: 840-852. doi: 10.1111/1365-2435.13539
- Brambilla M., Resano J., Scridel D., Anderle M., [...] & Rubolini D., 2018. Past and future impact of climate change on foraging habitat suitability in a high-alpine bird species: management options to buffer against global warming effects. *Biol. Conserv.* 221: 209-218. doi: 10.1016/j.biocon.2018.03.008
- Brambilla M., Anderle M., Bazzanella M., Capelli F., [...] & Scridel D., 2018. Landscape-associated differences in microhabitat selection modulate the potential impact of climate change on animal species. *Bird Study*, 65: 525-532. doi: 10.1080/00063657.2018.1561646
- Cerritelli G., Bianco G., Santini G., Broderick A.C., [...] & Åkesson S., 2019. Assessing reliance on vector navigation in the long-distance oceanic migrations of green sea turtles. *Behav. Ecol.* 30: 68-79. doi:10.1093/beheco/ary166
- Cerritelli G., Vanni L., Baldaccini N.E., Lenzone A., [...] & Giunchi D., 2020. Simpler methods can outperform more sophisticated ones when assessing bird migration starting date. *J. Ornith.* 161: 901–907. doi: 10.1007/s10336-020-01770-z
- D’Amelio P.B., Trost L. & ter Maat A., 2017. Vocal exchanges during pair formation and maintenance in the zebra finch (*Taeniopygia guttata*). *Front. Zool.* 14:13. doi: 10.1186/s12983-017-0197-x
- D’Amelio P.B., Klumb. M., Adreani N.M., Gahr C.M. & ter Maat A., 2017. Individual recognition of opposite sex vocalizations in the zebra finch. *Sci. Rep.* 7: 5579; doi:10.1038/s41598-017-05982-x
- Ferretti A., Maggini I., Cardinale M. & Fusani L., 2020. Heat loss in sleeping garden warblers (*Sylvia borin*) during migration. *J. Therm. Biol.* 102772. doi: 10.1016/j.jtherbio.2020.102772
- Ferretti A., McWilliams, S. R., Rattenborg, N. C., Maggini, I., Cardinale, M., & Fusani, L. (2020): Energy stores, oxidative balance, and sleep in migratory garden warblers (*Sylvia borin*) and whitethroats (*Sylvia communis*) at a spring stopover site. *Integr. Organ. Biol.* 2: obaa010.
- Ferretti A., Maggini I., Lupi S., Cardinale M. & Fusani L., 2019. The amount of available food affects diurnal locomotor activity in migratory songbirds during stopover. *Sci. Rep.* 9: 1-9. doi:10.1093/iob/obaa010. doi: 10.1038/s41598-019-55404-3
- Ferretti A., Rattenborg N.C., Ruf T., McWilliams S.R., [...] & Fusani L., 2019. Sleeping unsafely tucked in to conserve energy in a nocturnal migratory songbird. *Curr. Biol.* 29: 2766-2772. doi: 10.1016/j.cub.2019.07.028
- Gill L.F., D’Amelio P.B., Adreani N.M., Sagunsky H., [...] & ter Maat A., 2016. A minimum-impact, flexible tool to study vocal communication of small animals with precise individual-level resolution. *Methods Ecol. Evol.* 7: 1349-1358. doi: 10.1111/2041-210X.12610
- Giunchi D., Baldaccini N.E., Lenzone A., Luschi P., [...] & Vanni L., 2019. Spring migratory routes and stopover duration of satellite tracked Eurasian Teal (*Anas crecca*) wintering in Italy. *Ibis* 161: 117-130. doi: 10.1111/ibi.12602
- Huber N., Fusani L., Ferretti A., Mahr K. & Canoine V., 2017. Measuring short-term stress in birds: Comparing different endpoints of the endocrine-immune interface. *Physiol. Behav.* 182, 46-53. doi: 10.1016/j.physbeh.2017.09.017
- Ligorio E., Tuliozi B., Hoi H. & Griggio M., 2020. Flock-dependent exploitation of a limited resource in House Sparrow. *Sci. Rep.* 10: 1-11. doi: 10.1038/s41598-020-64283-y
- Penner A.M., 2015. Gender inequality in science. *Science* 347: 234-235. doi: 10.1126/science.aaa3781
- Scridel D., Bogliani G., Pedrini P., Lemma A., [...] & Brambilla M., 2017 Thermal niche predicts recent changes in range size for bird species. *Clim. Res.* 73: 207-216. doi: 10.3354/cr01477
- Scridel D., Brambilla M., Martin K., Lehikoinen A., [...] & Chamberlain D.E., 2018. The effects of climate change on Holarctic mountain and upland birds: a review and meta-analysis. *Ibis* 160: 489-515. doi: 10.1111/ibi.12585
- Strinella E., Scridel D., Brambilla M., Schano C. & Korner-Nievergelt F., 2020. Potential sex-dependent effects of weather on apparent survival of a high-elevation specialist. *Sci. Rep.* 10: 8386. doi: 10.1038/s41598-020-65017-w
- Tocchioni, V., Petrucci, A. (2020). Italian PhD students at the borders: The relationship between family background and international mobility". DiSIA Working Paper 2020/10. doi: 10.13140/RG.2.2.28015.66729

Special Review

Tóth Z., Tuliozi B., Baldan D., Hoi H. & Griggio M., 2017. The effect of social connections on the discovery of multiple hidden food patches in a bird species. *Sci. Rep.* 7: 816. doi: 10.1038/s41598-017-00929-8

Tuliozi B., Camerlenghi E & Griggio M., 2020. Dynamic dyads: leader-follower dynamics across different contexts in House Sparrow. *Behav. Ecol.* doi; 10.1093/beheco/araa148.

Tuliozi B., Fracasso G., Hoi H., Griggio M., 2018. House sparrows' (*Passer domesticus*) behaviour in a novel environment is modulated by social context and familiarity in a sex-specific manner. *Front. Zool.* 15: 16. doi: 10.1186/s12983-018-0267-8

This work is licensed under the Creative Commons Attribution-ShareAlike 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-sa/4.0/>.

