OVIDIUS UNIVERSITY CONSTANȚA

DOCTORAL AREA: BIOLOGY

SUMMARY OF THE HABILITATION THESIS

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Summary

In the first part of this thesis, I summarize my professional (research and academic) trajectory since completing a PhD program in Biology in 2015, highlighting the most significant achievements up to date, while in the second part I present a proposal for future career development.

I started my scientific career as a research assistant during a doctoral program in Biology at Ovidius University Constanta (OUC). Since 2015, I participated in four national and seven international scientific projects at OUC, where I currently occupy a full-time research position (researcher gr. III). During the same period, I was awarded five research and five mobility grants through national and international competitions. The outputs of my research activity after completing the PhD (2015-present) were published predominantly in ISI journals (18 out of 19 papers), of which 56% in high-ranking journals (Q1 and Q2). I am a principal author in 63% of the papers published during this timeframe. I also had a sustained peer-review and editorial activity over the years (Publons profile).

I started a teaching career since 2019, by conducting seminars for master programs at two universities: OUC (Faculty of Natural and Agricultural Sciences) and the National University of Political Studies and Public Administration (SNSPA, Faculty of Political Sciences). At OUC, I also supervised bachelor and master students' projects and provided training sessions in laboratory (skeletochronology) and field techniques (biodiversity inventory and monitoring) to interested students from OUC and visiting doctoral students through the Erasmus program.

Most of my scientific work was conducted in the fields of Population Biology, dealing with concepts in the framework of *Life History Theory*, and Bioacoustics, focusing on acoustic communication patterns. An additional line of research is related to the field of Biological Invasions, which has developed significantly during the past two decades, in response to the increasing threats posed by alien species to both biodiversity and human health and welfare worldwide.

I used vertebrates as a focal group of taxa, with most of the studies being centered on amphibians as model-organisms. Amphibians are an ideal group for ecological, evolutionary and conservation studies specifically due to their complex and diverse life-histories, and since they occupy both terrestrial and aquatic habitats, their study provides valuable insights for both environments.

The presentation of the most significant scientific achievements is structured following four major topics:

I. Aging and growth patterns in amphibians;
II. Adaptive strategies and resilience to environmental stress during early life history;
III. Using bioacoustic signals to study biodiversity patterns;
IV. Alien species.

Life History Theory provides the analytical framework for studying the mechanisms that drive organisms' life histories towards achieving reproductive success and survival in relation to extrinsic (i.e. environmental) and intrinsic (i.e. genetic) constraints. I used skeletochronology to study two central biological processes under this framework, aging (i.e. the process of senescence) and growth (i.e. size-increment with age), using amphibians as model-organisms. These studies aimed to explain life-history strategies in response to: (i) extreme temperature and precipitation regimes, (ii) interspecific competition, (iii) hybridization, and (iv) habitat loss and fragmentation. The results of these studies showed that amphibians inhabiting seasonally arid habitats (like the dry forests in South-America) exhibit fast growth and high reproductive investment but have a short lifespan; in contrast, amphibians from the temperate region appear to exhibit lower growth rates and longer lifespans. The life-histories of some temperate amphibians appear to be rather shaped by interspecific competition, hybridization and unpredictable environmental events (like floods or droughts), which is also reflected in their fitness. Populations of largely-distributed amphibians from the temperate region also exhibit a larger array of trade-offs that allow them to better cope with hostile environments. In terms of threats, the results showed that habitat loss and fragmentation leads to decreased fitness, reduced size and lower lifespan.

I conducted or participated in experimental studies aiming to explain the role of several stress factors like salinization, and food and light availability in shaping life-history strategies during early life stages of amphibians. The results of these studies showed that tolerance to salinity can vary greatly between related species and shaped their coexistence in sympatry by affecting offspring survival, size and fitness. Food and light availability during early development shaped antipredator responses by increasing shelter-seeking behavior, but not by reducing activity, in the presence of a refuge. In addition, refuge-emergence probability was determined by the interaction between predation risk, food, and light availability, which emphasizes the requirement to assess multiple environmental effects and their interactions when studying behavioral variation in animal populations.

Acoustic signals are some of the most conspicuous indicators of animals' activity and behavior, and can be both genetically and environmentally controlled; therefore deciphering the information encoded within vocal repertoires and analyzing their variability in time and space is vital to tracing and understanding evolutionary and behavioral patterns. In the field of bioacoustics, I contributed to the description and analysis of acoustic signals in anurans, showing that both mating and release calls are valuable tools to study population responses to environmental variability, and that both can store phylogenetic signals. I also showed that mating calls in a nest-building neotropical anuran are shaped by local climate, size and age, which could indicate female preferences for older males with better skills in nest construction. During a pilot study in a natural protected site in Romania, I characterized and compared the soundscapes in a peatland area by quantifying their diversity, complexity and level of disturbance. I identified a distinct and more benign component of anthropophonies, and as such propose this component as a novel sub-category within soundscapes, with potential benefits for the conservation and management of vulnerable ecosystems embedded in rural landscapes.

Human-driven biotic invasions are among the most important drivers of biodiversity loss and ecosystem service changes, second only to the direct destruction of habitats. The mechanisms by which alien species affect biodiversity are multiple and often synergistic with other factors, like climate change, habitat fragmentation, changes in land use, and pollution. Documenting all aspects of biological invasions is important for identifying the most effective measures to halt the dispersal of alien species and support their control and eradication. In the field of biological invasions I contributed to: (i) documenting the presence, distribution and status of alien species in Romania, (ii) the assessment of potential best practices for the management of alien species in Romania, (iii) the preparation of a national guide for monitoring vertebrate alien species in Romania, (iv) testing and promoting tools for citizen science to support the early detection and monitoring of alien species in Europe, and (v) identifying the origins of alien populations and pathways of introduction.

In my presentation of the plan for future career development I propose modalities of intertwining and balancing research and academic activities. The current research position at Ovidius University Constanta (OUC) grants me access to the research infrastructure, equipment and other facilities at the university, while the teaching position at the Faculty of

Natural and Agricultural Sciences allows me to establish connections with talented students interested in participating in research projects or pursuing a doctoral program.

I intend to continue my work on the research directions presented so far, while also shifting towards a more hypothesis-based approach, using the previous results as starting points, and moving on towards a higher degree of complexity and/or novelty. I intend to diversify the range of model-organisms, and thus also expand the utility and applicability of my research. In addition, I will strive to pursue a more conservation-oriented research, aiming at testing and developing tangible solutions for conservation managers and policy makers.

(I) Aging and growth trajectories in vertebrates. Skeletochronology can be applied virtually in all vertebrate groups, and I intend to expand the array of model-organisms in the study of life-history trajectories. Furthermore, I intend to shift towards a macro ecological approach, by testing and comparing aging and growth trajectories across multiple taxa and biogeographic ranges.

(II) Adaptive strategies and resilience to environmental stress. I intend to continue my previous research regarding the impact of salinization of the breeding habitats on the survival and fitness of amphibians inhabiting coastal wetlands. I plan to set up mesocosm and laboratory experiments to investigate whether water salinity is a significant factor in breeding-site choice by amplectant pairs. Next, I intend to evaluate the carry-over effects of salinity across all life stages by measuring a suite of life-history traits, fitness and behavioral changes. I intend to set up a similar experimental design to test the effects of most commonly-used chemicals (i.e. for pest control, either in agriculture, or urban settlements) in areas close to the wetlands associated with the Romanian Black Sea coast.

(III) Using bioacoustic signals to study biodiversity patterns. I intend to expand my research into the field of Soundscape Ecology. Passive acoustic monitoring (PAM) tools became more accessible during the last decade and multiple dedicated analytical tools were developed. Building on the experience from previous and ongoing research projects in natural protected areas from Romania, I will use PAM to: (i) improve the early detection of alien species, (ii) assess the impact of fish introductions in alpine lakes, (iii) assess the impact of anthropic activities like tourism and grazing, (iv) assess the impact of alien species on native biodiversity, with a focus on priority habitats along the Black Sea coast. Finally, I intend to set up a curated acoustic library at OUC, following the example of FonoZoo (Fonoteca Zoológica del Museo Nacional de Ciencias Naturales de Madrid).

(IV) Alien species. Understanding the mechanisms by which alien species spread and affect native biodiversity is essential in drafting effective measures to halt their dispersal and aid their control and eradication, while also supporting the recovery of impacted ecosystems. In addition to using PAM tools, I intend to set up mesocosm and laboratory experimental designs to evaluate the effects of alien fish on native (amphibian) communities related to: (i) breeding-site preferences, (ii) behavior during early life stages, and (iii) life-history trajectories and fitness across all life-history stages.

Students represent an important asset in research projects in universities. To better keep a connection with talented and passionate students, I intend to create a dedicated group for Population Biology studies at OUC. This will serve as a platform for collaborative work and research, where bachelor and master students can interact with doctoral candidates, postdoctoral and senior researchers with similar interests. The focus of the group will be in the field of population biology, dealing with concepts and techniques from biology, ecology, evolution, systematics, conservation, and statistics. The group will enable students to acquire early-on scientific writing (papers, grant proposals) and analytical (tools and methods in biostatistics) skills, and first-hand experience by participating in ongoing research activities. I will continue to participate to national and international grant competitions in order to obtain additional funding to support the research activities, but also to be able to provide paid positions to students involved in research. I will keep my teaching and research skills up to date by participating in training programs, either dedicated courses, or stages abroad. For this purpose, I will keep participating in competitions for mobility grants. For example, during the past four years I obtained two mobility grants through the Erasmus+ program, and three by participating in dedicated national competitions from UEFISCDI (the national funding agency for research in Romania). Such mobility programs are particularly beneficial in terms of creating or expanding academic/ research networks, paving the way for future collaborative projects or strengthening existing connections.

The habilitation is the next natural step in the development of my academic and research career, allowing me to form my own team while maintaining the present network of collaborators, which will help me to evolve as a scientist and achieve the goals proposed in this thesis.