Exploring species interactions in wetland restoration and their effects on ecosystem processes and services.

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Coastal wetlands are some of the most valuable but at the same time threatened marine coastal ecosystems and their restoration is emerging as a pressing management strategy to combat and reverse their loss. Many restored wetlands, however, fail to completely achieve the structure and functioning of natural communities, and the cost/effectiveness of these interventions is currently low. This underperforming has been at least in part attributed to a limited understanding and incorporation of species interactions in wetland restoration practice. The aim of this PhD project is to study the biotic regimes that can support the restoration of wetland vegetation (saltmarsh and/or seagrasses) in Venice Lagoon. Here, current work has focused mostly on the physical and hydrologic regimes needed to sustain wetland restoration, but virtually nothing is known about the role of critical biotic factors, such as the control by grazers and/or top predators or habitat facilitation cascades. The student will use a combination of field sampling of ongoing real-scale restoration actions in the region and field- and laboratory- based manipulative experiments to: 1) identify relevant biotic control in wetland restoration; 2) measure how the strength and generality of these controlling mechanisms vary with critical environmental conditions (such as levels of nutrient enrichment or wave exposure); and 3) measure how biotic control affects restoration success not only in terms of vegetation growth, but also influencing the delivery of critical ecosystem services such as species richness and carbon sequestration. The successful applicant should have a background in one or more of the following fields: marine ecology, restoration ecology, experimental ecology, ecosystem services evaluation. Training in Scientific Diving, or at least evidence of capability to work in the field in the sea (i.e. capability to swim) is also requested, as well as English language proficiency. Data analysis proficiency with R is regarded as an advantage.

Studying gymnosperms to understand seed plants evolution: unraveling reproductive mechanisms in *Ginkgo biloba L*.

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The appearance of the seed was one of the main steps forward in the evolution of land plants. A seed derives from a fertilized ovule and is mainly formed by a seed coat that protects the developing embryo within it. Ovule and seed development are crucial processes in seed plant reproduction. Most of the molecular studies have focused so far on ovule and seed formation in angiosperms. However, for a complete understanding of the evolution and development of ovule and seeds, gymnosperms have to be considered. In this research, the gymnosperm *Ginkgo biloba*, due to its key phylogenetic position and remarkable evolutionary history, will be used to study the reproductive process, focusing on mechanisms controlling ovule development, pollination, and seed coat differentiation into a fleshy fruit-like structure. Detailed morphological, metabolomic, transcriptomic and expression analyses will be performed to identify key regulators involved in *Ginkgo* reproductive mechanisms from ovule determination to pollination and to seed development. Signal molecules released by the pollen grains and the role of the male gametophyte in triggering the ovule formation will be also investigated as well as the epigenetic landscape of specific regulatory genes during the early steps of the reproductive process.

The ecological role of dissolved oxygen oscillations in marine ecosystems.

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Dissolved oxygen is crucial for marine life, yet its influence on biodiversity and ecosystem functioning is far from understood. The average oxygen content of the oceans is decreasing due to global warming with poorly understood consequences for marine biota, and recent research has shown that in productive coastal environments dissolved oxygen can display regular but extreme daily oscillations from hypoxic to strongly hyperoxic, with potential widespread effects on species metabolism and behavior and biogeochemical cycling. This project aims to clarify the ecological role of dissolved oxygen oscillations in water bodies, focusing mainly on marine ecosystems, through a combination of observational and modelling tools. These tools include: high frequency monitoring of oxygen fluctuations and water quality in water bodies in the Adriatic coastal area, including productive habitats of the Venice Lagoon such as salt marshes and seagrass and seaweed beds; laboratory experiments to better quantify the recently-realized

protection against thermal stress for aquatic fauna provided by oxygen supersaturation, and explore its influence on resilience to hypoxia and nutrient cycling; analysis of open-access datasets covering multiple ecosystems worldwide (e.g. oceanographic cruises); e cological modelling (biogeochemical and habitat suitability modelling) to synthesize experimental results and project them in a global change context. This project will advance our knowledge on marine ecosystem functioning generating advices to support marine conservation and management.

Evolutionary routes to endemism in alpine rockfoils.
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Mountains are storehouses of biological diversity and harbor a high degree of endemism. Endemism and species richness are highly relevant for conservation prioritization applications, yet we lack a mechanistic understanding of the processes driving divergence and speciation in mountain regions. In recent years comparative and landscape genomics combined with phenotypic, environmental and geographic information have provided powerful approaches to unravel the underpinnings of evolutionary responses and, especially, of mechanisms of speciation giving rise to the high levels of endemism found in these regions. This PhD project aims at identifying genomic footprints of speciation and drivers of divergence in Alpine endemics. By deploying cutting-edge genomic tools on herbarium and present day samples in combination with phenotypic and environmental data, the student will investigate speciation patterns and demographic histories of alpine rockfoils (*Saxifraga L.*) with focus on high-elevation endemics. Shedding light on the patterns and drivers of evolutionary novelty and speciation in mountain ecosystems will provide key missing information to understand the origin and evolution of these biodiversity hotspots and to predict their response to global change.

Effects of heatwaves on reproduction and behaviour in a model insect species.
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Rising temperatures are posing a serious threat to biodiversity and animal abundance, but the underlying reasons remain poorly understood. While its effect on survival has been long studied, recently it has become evident that increasing temperatures deeply affect reproduction, and that the thermal threshold for fertility is much lower than the critical temperature for an organism's survival. Therefore, studying the effect of temperature on fertility will help to better predict a species' resilience and persistence in our rapidly changing world. The frequency and intensity of heatwaves is increasing and is set to escalate even more in the coming decades. A short but sudden temperature change, such as that experienced during heatwaves, can have important consequences on various aspects of fertility, especially for organisms with limited ways to escape or to compensate costs, such as ectotherm and short living species. However, how heatwaves impact reproduction and associated behaviours are still mostly unknown in most species. In this project we will expose insects to experimental heatwave in the laboratory, to study consequences of heatwaves on various aspect of fertility and behaviour. This will ultimately help to understand how heatwaves affect fitness of individuals and populations and predict how populations will cope with climate change in the near future. Specifically, the project aims to understand how different individuals in a population respond to thermal stress, what are the consequences of heatwaves experienced during different life stages, and whether these effects can cross generations (causing trans-generational effects). The study species will be an insect, the hissing cockroach, *Gromphadorhina portentosa*, and the project will be in collaboration with Dr Cristina Tuni at LMU (Munich) and the Esapolis museum (Padova).

How the theory of evolution is evolving.
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The neo-Darwinian theory of evolution is evolving, thanks to new knowledge, discoveries, data extensions, models. In philosophy of science, this means that it is an healthy research program. But how is its structure changing? The journal Nature in 2014 gave a simplified representation of the debate: as a dichotomy between "reformers" and "conservatives". The proposal for an "Extended Evolutionary Synthesis" (2010) was unsuccessful, due to its vagueness. Meanwhile new relevant discoveries have been added. The PhD research program (in theoretical biology) will be aimed at a new proposal for interpreting and formalizing

the advancements (through inclusions and revisions) of the evolutionary research program. The research will be part of an already established International network, with several missions abroad. In addition to case-studies and publications, an International conference will also be held in Padua, at the end of the three years, with the main actors of the debate.

Sexual selection in a changing world.
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Sexual selection occurs whenever a trait, in males or females, is associated with a differential reproductive success solely in respect to the access of partners of the opposite sex. In resource-free mating systems, sexual selection can align with natural selection, and hence improve the adaptation of populations, when genetic benefits associated with paternity biases are larger than the costs associated with inter- and intra-locus sexual conflict. Most empirical studies conducted so far seem to suggest that sexual selection is dominated by sexual conflict, although some suggest that net genetic benefits to females may prevail when populations are off their adaptive peak. Under such circumstances, sexual selection reduces the load of deleterious mutations and aligns with, rather opposing to the action of natural selection. These results concur suggesting that sexual selection may be a crucial component of adaptation to new, adverse environmental conditions caused by human activities. Unfortunately, this evidence comes from small invertebrate model species, such as Drosophila, which are characterized by large populations sizes and high fecundity, and to which extent this apply to larger animals, such as vertebrates, with typically small population size and low fecundity is unclear. We will use the guppy (*Poecilia reticulata*), as a model species to investigate the role of sexual selection in purging deleterious mutations under different environmental conditions. Guppies can be studied in controlled conditions in the lab using meaningful experimental manipulation of the ecological conditions and of the intensity of pre- and post-mating sexual selection. The ideal candidate should have a keen interest in evolutionary biology and animal behaviour, and previous experience working with animals. The PhD student will join a dynamic team working on sexual selection and we are seeking candidates with a good predisposition to collaborative, interdisciplinary work.

Mate choice, personality and evolutionary genomics in freshwater fishes.
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Use behavioral and genomic approaches to study the relationship between mate choice, personality, and cognition in swordtail fishes, with extensive stays at CICHAZ (www.cichaz.org) in the Sierra Madre Oriental of Mexico. The ideal candidate will be able to communicate in Spanish and have experience with either fish husbandry and/or bioinformatics. The specific topic of the dissertation will depend on the student's expertise and interests, and can range from analyses of natural and sexual selection on male display traits and female mating preferences in a long-term evolutionary experiment, to neurogenomic studies of the mechanisms underlying social plasticity in personality and mate choice.

Environmental DNA application to monitor biodiversity and to detect alien species in freshwater and lagoon ecosystems.
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Environmental DNA (eDNA) is an emerging tool for assessing biodiversity and understanding spatial and temporal community patterns and processes, directly from sequencing of DNA obtained by environmental samples such as air, water and sediments. Despite its attractiveness, the eDNA application is complex and involves multiple steps from field sampling design, lab work, and bioinformatics analyses with the robustness of results strictly linked to adequate experimental and modeling methods, accounting for spatiotemporal variation, uncertainty in eDNA collection, and imperfect detection. This project will apply eDNA to long term monitoring of the vertebrate and invertebrate community and to detect invasive species at selected freshwater and lagoon sites from Veneto region and Venice lagoon. The project will involve field work, laboratory work and bioinformatic analysis and it will be performed in an existing collaboration network aimed at developing methodological advancements to monitor biodiversity changes at the ecosystem/seascape level. The ideal candidate should be interested both in the development/application of molecular tools than in bioinformatic/statistical analysis of data; previous experience with eDNA approaches will be appreciated. The PhD student will join an expanding group, dealing with eDNA tools, and will collaborate with other PhD students in Italy and abroad working on the same topic.