



EVOLUTIONARY ECOLOGY

EVOLUTION, BEHAVIOUR, ADAPTATION GROUP

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It is not the strongest of the species that survives, or the most intelligent ; it is the one most capable of change

Mots clés: Plasticité phénotypique, Biologie de l'invasion, Température, Drosophila



Phenotypic plasticity and adaptive responses to environmental change

My research work has allowed me to explore different aspects concerning the adaptive responses of organisms to environmental changes, mainly temperature, on the insect model and especially on *Drosophila* through a comparative approach. I was particularly interested in phenotypic plasticity which can be defined as the ability of a genotype to produce different phenotypes according to environmental conditions. Phenotypic plasticity is a phenomenon that can be generalized to all living organisms and that can be found in all species and for a wide variety of phenotypic traits.

The main questions addressed during my research are :

How to analyze the shapes of non-linear reaction norms? Do these reaction norms present genetic variability? How do these norms evolve between populations and between species? Do these comparisons provide arguments for adaptive phenotypic plasticity?

How will environmental variability (thermal fluctuation) impact the shape of response norms? What about environmental complexity (combination of several factors)?

What is the importance of phenotypic plasticity as a response mechanism to environmental perturbations?



On this issue, I am coordinating the ANR TRAPP project, which started on January 1, 2025 for 4 years and involves two LBBE teams (GEI and ECE), the CASPER unit of Anses in Lyon and the Institut de Génétique Humaine in Montpellier.

Agriculture and vector control programs make intensive use of chemical insecticides to control insect pests and disease vectors. They represent a major selection pressure for insect populations.

Transgenerational plasticity (TGP) is a form of non-genetic inheritance in which a change in the phenotype of offspring is triggered by an environmental signal in the parental generation without involving genetic modification. The existence of the TGP process is no longer disputed, but many questions remain, notably concerning the molecular mechanisms of these intergenerational effects and the persistence of TGP over more than two generations. In this project, we propose to use the experimental power offered by *Drosophila melanogaster*, a model species in physiology, developmental biology and genetics, to explore TGP in response to insecticides. Molecular mechanisms linked to TGP, particularly epigenetics, will be studied. This species can also be considered a sentinel species, representative of insect species exposed to contaminants in most agroecosystems, such as the *Drosophila* sp. community and the related pest species *D. suzukii*, but observations can probably be generalized to other arthropods. The study of the transgenerational impacts of insecticides is still little taken into account in insecticide risk assessment.



***Drosophila suzukii*: a recent biological invasion and a major economic threat**

For the past few years, my research activity has focused on a project concerning a very recent biological invasion event involving a fruit crop pest, *Drosophila suzukii*. At the fundamental level, we were first interested in the ecological factors that explain the invasive success of this species whose biology was poorly known. We showed that French larval parasitoids were unable to control *D. suzukii* populations because of its very high immune resistance capacity. We also showed that this species has a very wide range of wild host plants present throughout the year and we highlighted an interesting case of self-medication in *D. suzukii*. Moreover, our results suggest that if *D. suzukii* does not really have competitors on healthy fruits, it can undergo a strong larval competition with *D. melanogaster* on rotten fruits on which an oviposition avoidance behavior is observed. Current projects aim to use the recent and spectacular invasion of *D. suzukii* to better understand the mechanisms of adaptation to a new environment, in particular the role of phenotypic plasticity. Finally, some projects have also been developed to consider new control methods against this formidable crop pest.



Marie Panza's thesis, which I am co-supervising with Laurence Mouton (LBBE) and Vincent Foray (IRBI Tours), focuses on the resistance capacity of the crop pest *Drosophila suzukii* to a parasitoid recently introduced into France, *Leptopilina japonica*. To this end, we propose a three-part study: 1) To characterize the variation in resistance to *L. japonica* between invasive European populations of *D. suzukii* and look for potential trade-offs with fitness-related traits. 2) Test the influence of environment and microbiota on *D. suzukii* resistance to *L. japonica*. This part will focus on the effect of the nutrient environment and the heritable bacterium *Wolbachia*. 3) Identify the proximal factors underlying variation in resistance to *L. japonica*. This analysis will investigate the molecular mechanisms underlying intra-specific variation in *D. suzukii*, but also inter-specific variation between *D. suzukii* and another *Drosophila* species, *D. melanogaster*. From a fundamental point of view, this study will contribute to our understanding of the ultimate and proximal factors involved in host-parasitoid resistance variation. From an applied point of view, it will provide valuable results for the development of a biological control program against *D. suzukii* and the assessment of risks of resistance emergence. This project is being carried out in close collaboration with our colleagues in the Biological Control Research and Development team at ISA Sophia Antipolis.

Physiological basis of insect community responses to climate change

This collaborative project is led by **Cameron Ghalambor** (Professor) Norwegian University of Science and Technology, Norway

<https://www.ntnu.edu/employees/cameron.ghalambor> 

The earth's climate is evolving rapidly, leading to observable changes in the abundance and geographical distribution of insects. These changing climatic conditions could lead to a global decline or, on the contrary, the growth of certain insect species. Insects play an important role in ecosystem functioning, crop pollination and disease transmission, so understanding the causes of these changes is an important issue for biodiversity, agriculture and human health. To date, our understanding of insect physiological responses to climate change is based mainly on thermodynamic and energetic responses to temperature. However, the integration of the combined effects of temperature on water loss and desiccation risk is important to consider. Insects are particularly vulnerable to desiccation due to their small size and limited water storage capacity. They lose water as the temperature rises across the surface of their cuticle and through high respiration rates. Research has shown that the thermal sensitivity of water loss and metabolism varies from species to species, but no study to date has attempted to systematically describe these patterns in insect groups and in climates varying in temperature and precipitation. We propose to fill this gap by investigating the thermal sensitivity of metabolic rate and water loss in insect species from different climates in Europe. We will combine these data with climate projection models to build new models for predicting how species will respond to future conditions.

Responsabilités

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› Membre de la Commission scientifique Sciences Exactes et Naturelles-4 (SEN-4) et de la Commission scientifique Sustainability du

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