agropolis fondation

LAGRO

ABSTRACT

One of the greatest challenges to global food security is the increasing loss of food production due to insect pest species. Adaptation to new environments is a key process for pest species that enables them to colonize new plants and regions, but also to resist and bypass conventional pesticides and agronomical practices.
While adaptation is genetically encoded, the role of environmental effects (e.g., phenotypic plasticity) in molding genetic adaptation has gained increasing attention in evolutionary biology. Theoretical studies have now clearly established that learning(one component of the overall phenotypic plasticity) has the potential to modify evolutionary trajectories and accelerate, slow down or even prevent adaptation.
Our project aims at predicting the impact of insect pests' learning on their future adaptations to new crops and agroecological management strategies. As a proof of concept, we will test whether learning can change the direction and speed of evolution of the preference for their native host plant in the invasive Drosphila suzukii and the maize post Ostrinia nubilalis. For this, we will (i) develop an ad hoc experimental methodology, based on individual and high-throughput learning measurements, and (ii) estimate the effect of learning on the mean, the variance and the rank of the host choices for egg laying in gravid females.
From the concept to the technical locks, this project is by nature innovative and interdisciplinary as it stems from the objective of bringing knowledge and hypotheses drawn from cognitive sciences and evolutionary biology together. So far, these particular disciplinary fields have been largely ignoring each other, and we argue that the proposed action will demonstrate that associating them spawn original, potentially groundbreaking, avenues of research and control methods.

Year : 2020
Project number : 2001-018
Type of funding : AAP
Project type : AAP ABS
Research units in the network : CBGP
Start date : 2020-09-01
End date : 2021-08-31
Flagship project : no

Project leader : Réjane Streiff
Project leader's institution : INRA-INRAE
Project leader's RU : CBGP

Budget allocated : 24084 €
Total budget allocated (including co-financing) : 24084 €
Funding : Labex

GOAL

Insect pests of cultivated plants learn, evolve and adapt. They can colonize new crops, or bypass the control means that farmers engage to regulate them. Our project aims at predicting the impact of insect pests' learning on their future adaptations to new crops and agro-ecological management strategies. As a proof of concept, we will test whether learning can change the direction and speed of evolution of oviposition behavior in two species of phytophagous insects.
For this, we will (i) develop an ad hoc experimental methodology, based on individual learning measures, and (ii) estimate the effect of learning on the mean, the variance and the rank of the oviposition choices of individual females of each species.
This will help develop agronomic strategies sustainable to plastic behavioural changes and associated adaptations in pest species, and pave the way to new practices actively using insect learning to prevent

adaptation to valuable crops.
We have two specific objectives to achieve our main goal.
Our first objective is to establish a repeatable, high-throughput methodology to measure both innate and learned oviposition choices in individual females of O. nubilalis and D. suzukii. The new experimental protocols must be repeatable and standardized enough to ensure accurate and individual estimation of a trait that is notoriously prone to extreme variance (learning), both between individuals and within an individual's life. Additionally, the experimental procedures should enable high-throughput processing to test a sufficiently large number of individuals to estimate the evolutionary consequences of learning at the population level (i.e., several thousand phenotyped individuals), ideally in various environmental situations (e.g., to test phenotypic responses to various host transitions and control strategies).
Our second objective is to test theoretical expectations on the population-level phenotypical consequences of individual learning that will help predict the effect of learning on the direction and speed of adaptation. In brief, studies on phenotypic effects of learning have highlighted that individual learning may modify the population mean, variance and the rank of individuals in a behavioral task. In turn, theoretical works on the evolutionary consequences of learning predict that such change may either accelerate, slow down or prevent genetic change. By reshaping phenotypic mean, variance and/or rank, learning will indeed modify which genotypes are subject to natural selection and to what extent natural selection will operate on genetic variation. We will be able to test various environmental conditions (e.g., host transitions and management strategies) and challenge the notion that learning is inherently adaptive.