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Interviewing Ophélie Ronce

On the occasion of her visit to CREAF as part of the CREAFTalks program, we interviewed researcher Ophélie Ronce, director of the CNRS research group at the University of Montpellier and member of the CREAF Scientific Council since 2017. Ophélie studies the role of evolution in biodiversity response to global changes through mathematical models.

Ophélie Ronce / PWIAS

How would you explain your research and the talk you gave at CREAF in an informative way?

- In the conference I talked about evolution of phenology, which describes the dates of major events in the life cycles of plants and animals: flowering dates, bud opening dates, return formmigrations, etc. Very important dates for the life cycles of organisms and, at the same time, highly affected by climate change. For example, due to late spring, we see many species blooming earlier, earlier fruit picking dates and earlier migration, etc. My specialty is designing computer models that allow us to understand the evolution of traits that determine these dates and to study the evolution of phenology. I try to understand the consequences of advancing the dates of spring events with climate change, such as whether advancing dates really help plants and animals to persist in a warmer weather. I propose different models to understand what role these factors play in evolution. For example, if there are two plants in different stages of flowering, they can no longer be crossed between them and, therefore, the crosses are not random, but are limited to individuals that resemble each other in these phenological traits. These crosses are called homogamous. While there is natural selection affecting the flowering stage, there is also sexual selection, which affects the evolution of phenology. Our models have shown that this peculiarity of phenology explains why it may adapt fast to a changing climate.

What variables do you analyze to carry out your studies?

- Modeling is not like an experiment. I look at the relationship between the weather, the flowering date, the opening of the buds, the reproductive success of the trees, which helps understanding the natural selection on phenology in future climates. I then predict which dates will maximize the fitness of plants in the future and how fast these dates may evolve.

Some species are expanding their distribution. This expansion can be justified by climate change, but also by an adaptation of the species. How can we differentiate between an evolutionary adaptation and a direct impact of climate change?

- The experts contemplate two options for adaptation to climate change: not changing the climatic niche (always adapting to the same optimal conditions) and therefore moving to follow this climate; or evolving without moving. Theoretical models show that both probably act at the same time.

Despite the fact that predicting whether a particular species will change its distribution or adapt to new conditions is difficult, meta-analyses conclude that, if we compare the rate of northward expansion with the rate of climate change, there is a relationship between them.

Do the changes in biodiversity cause an increase in this biodiversity, a reduction or a maintenance but with replacement of the species?

- Generally, there is a crisis of diversity, we are losing diversity. Climate change is not the only force behind this, but there is a cocktail of many factors, among which climate change stands out. We must not forget that there is also natural exploitation, impact on the landscape, loss of habitat, pollution, etc. If we wanted to isolate climate change and its role in the state of biodiversity, I would not be able to answer exactly, there are cases of local extinction clearly linked to climate change, but as you point out, there are also places where new species arrive. However, the adaptation phenomena are too slow and there are more species that disappear than new species that arrive. We have seen that in past cycles of climate change, there has not necessarily been a loss of species, rather there have been community rearrangements (replacements) and often ecosystems analogous to current ecosystems, but with different species compositions. But experts are worried that the current speed of climate change is much higher than in the past.

What changes can occur during the life of a tree?

- There are many changes. The most important ones we see are changes in spatial distribution, abundance, and phenotypic changes due to phenotypic plasticity. Part of these phenotypic changes can be found in the speed of development, the size, the dates of the events of the plant life cycles, which in turn are conditioned by temperature, given the ectothermic nature of plants. Some of these changes that are inherited have been empirically tested through resurrection ecology, based on the simultaneous cultivation of ancient and current seeds. Some data also suggest that processes during seed maturation can causes offspring to express different traits in an environment where their parents were exposed to a different temperature.

There are also genetic variations observed through changes in allele frequencies associated with temperature increase. Finding these genes is a complex task as it is necessary to identify those with a direct impact on fitness. Some scholars note that examples of rapid genetic evolution due to climate change are quite rare and difficult to pin down, with those caused by human activity being more common.

Could we apply these research methodologies to humans? Are we humans adapting to climate change?

- Migrating, sure, we are already doing it. But unlike plants, we humans can change our practices without changing genetically. There are many examples of communities facing climate change by diversifying their culture, their way of building houses and producing food. Genetically, I have more doubts, but why not? There are diseases that are linked to climate change, there may be events of mass mortality as in the past, from which alleles emerge that confer a better adaptation to diseases. It is not impossible. Taking generation time into account and given the strong behavioral adaptive capabilities of humans, for there to be massive genetic change there must be a massive difference in fitness, reproduction, and survival, which implies many years. If we compare the genetic adaptation capacities of a plant, a bacterium, or a mosquito with those of a tree or a human that needs several years to reproduce, we conclude that we are conditioned by these timings and that at the genetic evolutionary level it represents a disadvantage.

Can the expansion of one species trigger the expansion or isolation of other species that coexist with it?

- This is an area in which more and more people are working. Species are not isolated from each other, and when one migrates, we find a case of competition with the species that occupies its niche. If the species lacks pollinators, dispersers, mycorrhizae, symbiotic organisms, it is difficult to propagate. Species are related to many other species, so when one expands it can lead to the expansion of other species. Phenology also shuffles these aspects. For example, if a tree flowers earlier, pollinating insects will also pollinate earlier, insects that eat trees and their birds predators will develop earlier, etc. What was synced before may not be synced now. More desynchronizations are expected in the near future.

How do you see the future of plants and their biodiversity?

- I do not know. We can make models to predict what is going to happen, as is done with meteorology, but we will never be able to integrate all the complexity of the interactions between species. There are many factors and discussions about which ones should be eliminated or kept. I don't know if we will be able to reach the level of climate prediction. However, it is an iterative scientific process, that is, even if you do not get the perfect model, you improve the understanding of the question. A very successful type of study since the early 2000s is to make projection models of climatic niches and use it to predict which species move, why they do it, if they will disappear, etc. In fact, these models can be used to make decisions about the management of nature in the future despite the degree of uncertainty that we have in these models. For example, beech is expected to disappear from the forests of Western Europe (France, Spain) because the climate is expected to become too hot. Faced with such a situation, foresters propose to stop planting beech, but if we stop planting it, it will surely disappear. What do we do? By anticipating the future, we may make it worse. At this rate, a tree does not have the same climate when it is born as when it reproduces, and therefore its genome has not changed yet, so when we plant trees, we must think about whether we want trees adapted to the current climate or to the future climate.

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