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FONDATION POUR LA RECHERCHE SUR LA BIODIVERSITÉ

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CENTRE FOR THE SYNTHESIS AND ANALYSIS OF BIODIVERSITY

Project summary

RED-BIO

Dynamic resource landscapes, eco-evolutionary feedbacks and the emergence of meta-food webs

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Start and finish: 2020-2022

Organisms move across the landscape to forage and disperse. This project studies how these movements, associated with the recycling of organism detritus (feces, mortality), can redistribute nutrients in the landscape and impact community dynamics.

Context and objectives

In ecology, we often study how the distribution of resources in landscapes constrains the production of biomass and biodiversity. For example, it is expected that the more nutrients there are locally, the more biomass will be produced, while biodiversity should be maximum at intermediate resource levels where there is not too much competition. However, this spatial distribution of resources is not fixed because organisms disperse and move to search for food at different scales. In doing so, they displace resources, while they consume for food and produce detritus (faeces, mortality) which is recycled locally. This should create hotspots where nutrients accumulate and cold spots where nutrients are overconsumed. In this project we seek to determine, with mathematical modelling tools, under which conditions the movement of animals, interactions between species and recycling

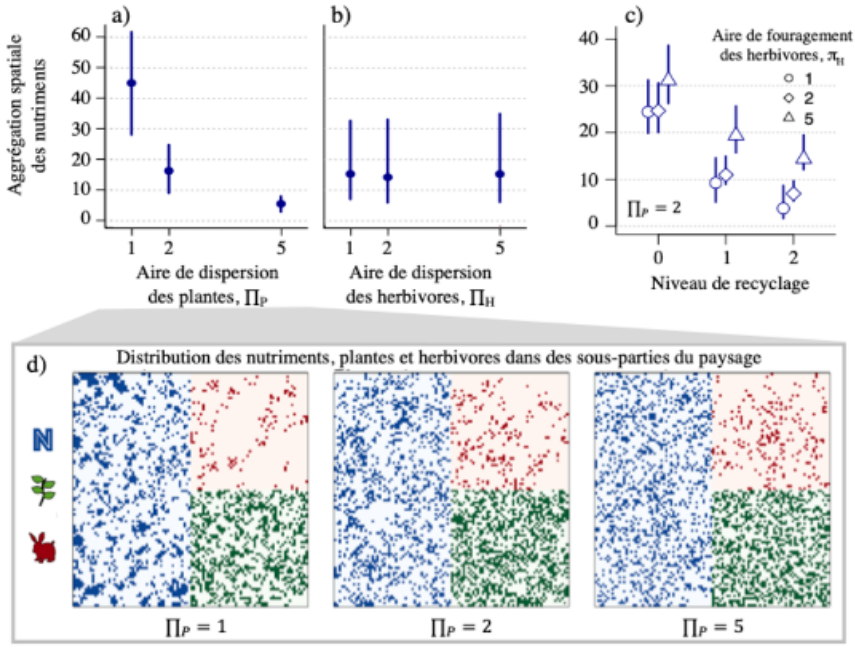
create spatial heterogeneity in nutrients in an initially homogeneous landscape, and what is the role and the importance of this heterogeneity for biological communities and their response to disturbances. We also intend to study how feedbacks between the ecology of organisms and the evolution of their traits linked to their movement capacities (for example body size) acts on these dynamics and affects biodiversity in a context of global changes.

Methods and approaches used for the project

To study these complex dynamics, we have developed a model that simulates the distribution of populations of a plant and an herbivore that feed, produce detritus, then recycle, and disperse in a homogeneous landscape. Herbivores compete for plants and space colonization varies with resource availability and local herbivory pressure. We carried out simulations of this model where we varied (1) the size of the area where the herbivore eats and produces detritus, and (2) where each of the two species disperses. We assess how and under what conditions these two factors affect the spatial heterogeneity of nutrients. .

Principal conclusions

Our simulations show that the dominant factor to observe the formation of nutrient patches in a plant herbivore system is to have a small dispersal area for the plants, ∏P (see a and d, in blue). In this case the plants aggregate (d) in green), which directly affects the nutrients they consume and forms cold spots where they are present. The size of the herbivore dispersal area, ∏H, does not matter (b) because the dispersal of herbivores is very constrained by the presence of plants. Their abundance is only high enough to affect nutrients when plants are very abundant with high recycling, which enriches the soil with nutrients. In this case, we observe an increase in the aggregation of nutrients with the foraging area of herbivores, πH (c). When the herbivore has a larger territory, it is less likely to go extinct because it has more plants available to it. It therefore stays longer in the same place and the recycling of its detritus creates nutrient hotspots.



Anticipated (or actual) impact of these results for science, society, and public and private decision making

The RED-BIO project is a theoretical ecology project that has **shed light on fundamental mechanisms by which the activity and movement scales of organisms (for foraging and dispersal) can create nutrient patches in an otherwise homogeneous landscape**. Given that habitat heterogeneity is a determining factor for the maintenance of species biodiversity, the project contributes to a better understanding of the dynamics of communities and their interactions with the environment which make it possible to create landscapes favorable to biodiversity.

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