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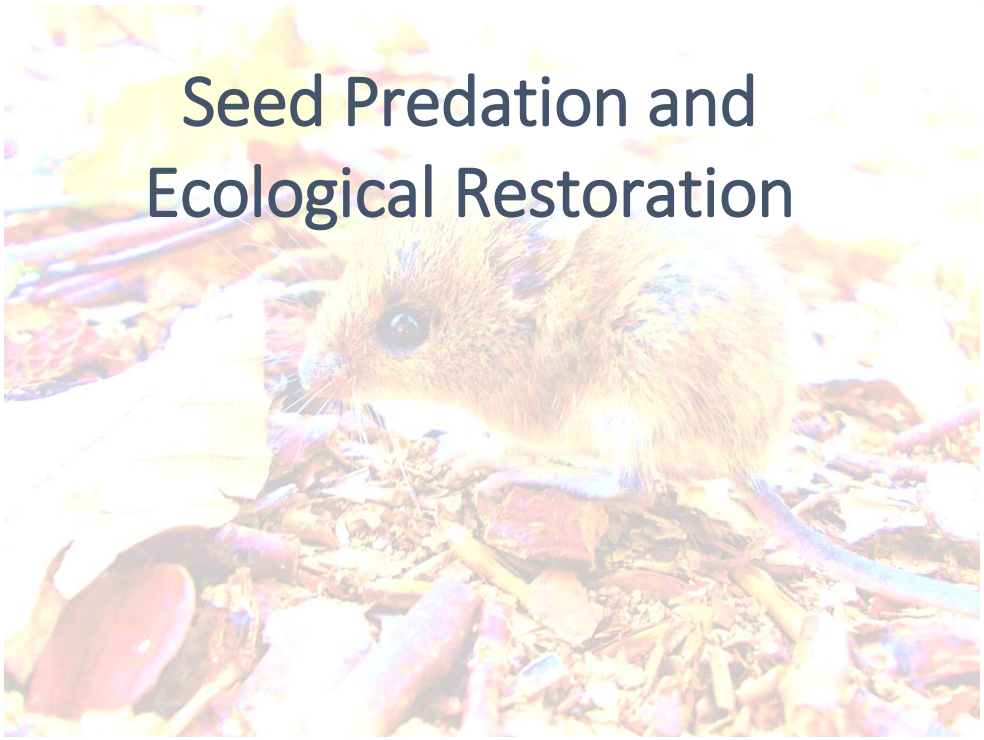
Seed Predation and Ecological Restoration



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AVERTISSEMENT

Cette recherche a fait appel à des lectures, enquêtes et interviews. Tout emprunt à des contenus d'interviews, des écrits autres que strictement personnel, toute reproduction et citation, font systématiquement l'objet d'un référencement.

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Formation par la recherche, Projet de Fin d'Etudes en génie de l'aménagement et de l'environnement

La formation au génie de l'aménagement et de l'environnement, assurée par le département aménagement et environnement de l'Ecole Polytechnique de l'Université de Tours, associe dans le champ de l'urbanisme, de l'aménagement des espaces fortement à faiblement anthropisés, l'acquisition de connaissances fondamentales, l'acquisition de techniques et de savoir-faire, la formation à la pratique professionnelle et la formation par la recherche. Cette dernière ne vise pas à former les seuls futurs élèves désireux de prolonger leur formation par les études doctorales, mais tout en ouvrant à cette voie, elle vise tout d'abord à favoriser la capacité des futurs ingénieurs à :

- Accroître leurs compétences en matière de pratique professionnelle par la mobilisation de connaissances et de techniques, dont les fondements et contenus ont été explorés le plus finement possible afin d'en assurer une bonne maîtrise intellectuelle et pratique,
- Accroître la capacité des ingénieurs en génie de l'aménagement et de l'environnement à innover tant en matière de méthodes que d'outils, mobilisables pour affronter et résoudre les problèmes complexes posés par l'organisation et la gestion des espaces.

La formation par la recherche inclut un exercice individuel de recherche, le projet de fin d'études (P.F.E.), situé en dernière année de formation des élèves ingénieurs. Cet exercice correspond à un stage d'une durée minimum de trois mois, en laboratoire de recherche, principalement au sein de l'équipe Ingénierie du Projet d'Aménagement, Paysage et Environnement de l'UMR 6173 CITERES à laquelle appartiennent les enseignants-chercheurs du département aménagement.

Le travail de recherche, dont l'objectif de base est d'acquérir une compétence méthodologique en matière de recherche, doit répondre à l'un des deux grands objectifs :

- Développer toute ou partie d'une méthode ou d'un outil nouveau permettant le traitement innovant d'un problème d'aménagement
- Approfondir les connaissances de base pour mieux affronter une question complexe en matière d'aménagement.

Afin de valoriser ce travail de recherche nous avons décidé de mettre en ligne sur la base du Système Universitaire de Documentation (SUDOC), les mémoires à partir de la mention bien.

PLAN

Introduction

Methods

Results

Location of the studies and species involved (Overview table of the study)

Pre- and post-dispersal seed predation: impacts on the restoration of ecosystems

Factors that can influence seed predation

Environment and near environment of the site under restoration

Micro-habitats present on the site

Seed morphology

Site treatment methods: differentiated impacts on seed predation

Discussion

Exclusion of certain predators

Seed protection from predators

Association of species and particular seeds

Conclusion

- Global impact of seed predation on ecological restoration
- Recommendations for improving the efficiency of restoration against seed predation

INTRODUCTION

First state of the plant life cycle, seeds play a key role in the process of natural succession and partly determine the occurrence of plants in a given environment. Consequently, they help to explain the species-richness and the evolution of plant communities, it is therefore essential to take into account their characteristics and dynamics in the management and preservation actions of naturals systems (Grubb 1977).

Indeed, seeds can represent an important limiting factor in the regeneration process of species since, if they are present in limited in terms of number or unsuited to the environmental conditions of the site, they can strongly compromise seedling recruitment and thus the survival of the entire plant population. Especially, this seed limitation can be explained by:

- A lack of sites with suitable conditions for seed germination and survival (microsite limitation).
- An insufficient dispersal (dispersal limitation), that doesn't permit seeds to reach enough favorable sites.
- The phenomenon of seed predation (predation limitation), responsible for the destruction of seeds (Orrock et al. 2006; Calviño-Cancela 2007).

These last two processes are of paramount importance because they can promote or on the contrary hinder the natural succession of systems and they contribute to structure plant communities by affecting the abundance and distribution of plant species (Lucas-Borja et al. 2016; Hulme 1998; Orrock et al. 2006). Moreover, their effect is particularly determining in early successional systems (Turnbull, Crawley, et Rees 2000; Orrock et al. 2006). As a result, these two processes can impact ecological restoration efforts.

Seeds, and more generally the fruits that envelop them, contain the biological material, especially the embryo, that will permit the birth of a new plants. Consequently, they constitute highly nutritive food resources (Hulme 1998; Schowalter 2016) and are the mainstay of the diet of some vertebrates, including birds and rodents and invertebrates (ants, beetles, etc.) (Schowalter 2016; Thorsen, Seddon, et Dickinson 2011; Brown et Ojeda 1987). These animals have specialized to greater or lesser degrees to find, collect or consume seeds (Brown et Ojeda 1987).

Depending on the fate of the seed, frugivorous and granivorous are considered as predators or dispersers. Since they don't have the same impact on the system, it's important to distinguish this two phenomena. Indeed, the dispersal process is characterized by the survival of the seed. Thus, the disperser organism will take the seed and hide it or bury it at a certain distance from the parent plant in order to consume it later: if it doesn't find it again and the seed is not consumed in the meantime by other organisms, then it has an opportunity to germinate. The behavior of seed dispersers varies according to species : for instance, rodents will generally remove the larger seeds to bury them elsewhere, while ants transport smaller seeds to their nest, where conditions are often more favorable for seeds to germinate (Schowalter 2016; Gómez, Espadaler, et Bas 2005). Some consumed seeds can also survive the passage through the animal's digestive tract. This way, the phenomenon of dispersion enables plants to colonize new habitats with more suitable conditions and to move away

from parent plants, near which mortality is often higher (Dennis 2007; Grubb 1977; Schowalter 2016), leading to an increase of the seedling recruitment success (Wang et Yang 2015). However, this study will only focus on the phenomenon of seed predation.

Unlike dispersion, in the case of predation, the organism consumes the seed so that it's no longer viable, often causing a decrease in the productive efficiency of plants, even the destruction of the entire production of viable seeds in a few years (Schowalter 2016; Calviño-Cancela 2007; Hulme 1998; Severns 2008). Seed predation can take different forms: thus, some predators consume the entire seed, such as vertebrates and ants for example; others consume only the endosperm, such as seed bugs and weevils; finally, others, such as seed wasps and seed maggots, grow and feed inside the seed (Schowalter 2016; Fox et al. 2012; Honek et al. 2009). Moreover, pre-dispersal predation must be distinguished from post-dispersal predation: indeed, pre-dispersal seed predators typically feed on the fruits and seeds developing on the parent plant, whereas post-dispersal seed predators must locate fruits and seed resources that have fallen to the ground (Schowalter 2016; Wang et Yang 2015; Hulme 1998). In most ecosystems, pre-dispersal predation is often attributed to invertebrates (e.g. beetles, ants, etc.) and post-dispersal predation to vertebrates (birds, small rodents,etc.) (Schowalter 2016; Brown et Ojeda 1987). If in established systems, seed predation enables the survival of granivorous populations and the maintenance of plants diversity (Grubb 1977; Hulme 1998; Paine et Beck 2007; Roselli 2014), in degraded systems in which seeds are limited in terms of recruitment, it's considered as a factor that can negatively impact natural regeneration and restoration attempts (Denham 2008; Roselli 2014; Calviño-Cancela 2007).

Ecological restoration is defined as the "process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (Clewell, Aronson, et Winterhalder 2004). Nowadays, owing to the important degradation of ecosystems due to human activities (deforestation, pollution, etc.) or natural causes, ecological restoration has a crucial role to play. Indeed, in some degraded areas with low resilience, it represents the main means to reverse land degradation, and to restore the ecosystem composition of the ecosystem, its functioning and its sustainability (Clewell, Aronson, et Winterhalder 2004). There are two main types of ecological restoration: the term of ''passive restoration'' is used when the disturbance(s) are reduced, allowing natural processes to drive restoration, and the term of "active restoration" when disturbance(s) are reduced or eliminated and restoration processes are led by human intervention (Cristofoli et Mahy 2010; Lake 2001).

"Barriers" to ecosystem restoration may have an abiotic origin (they are related to the system environment: soil conditions, water level or microclimate for example) or a biotic origin (Shimamoto et Torezan 2012; Grubb 1977) that is, they result from the interactions between the different species occupying the site. In many cases, the restoration of a system is limited by multiple factors. Thus, in order to ensure the success of the restoration operations, it's important to completely understand the various factors and processes that affect seedling recruitment, especially the phenomenon of seed predation.

Thus, understanding the role of the different phases of seed predation in the process of ecological restoration is important since this phenomenon may influence the composition and the structure of plants communities by exercising pressures on seeds characteristics and their spatial

distribution (Holl et Lulow 1997; Shimamoto et Torezan 2012). Thereby, a better understanding of complex patterns of predation would permit a better understanding of recruitment variations. Howerer, the influence of predation, particularly on ecological restoration, has rarely been evaluated.

The aim of this review is to analyze the impacts of seed predation on ecological restoration and how this process is taken into account in restoration projects. Otherwise, seed predation is a variable process, even within a same system, it is therefore difficult to give out generalizations about this phenomenon (Roselli 2014; Holl et Lulow 1997). For a better comprehension, it seemed also suitable to study the numerous factors that can influence it.

Thus, this report, by summarizing the results found, is intended to answer several questions:

- What is the impact of seed predation in the restoration process?
- What are the species involved in the process of seed predation according to the environments?
- What factors influence seed predation?
- By which way negative impact of seed predation can be minimized in restoration projects?

WHAT REMAINS TO BE DONE

The first part of our work focused on bibliographic research concerning the impact of seed predation on ecological restoration in order to draw up a state of knowledge about this subject.

Originally, our end-of-studies project was about the impact of predation on the restoration of tropical lawns located at high altitudes. However, given the few existing articles on the subject, we quickly extended our research to all terrestrial ecosystems to obtain a maximum of information. Contrary to what we expected at the beginning of our research, we were able to collect only about thirty articles on the subject, dealing for the majority with forest environments.

Thus, the rest of our work will consist in continuing our research to try to find new articles on the subject. Subsequently, we will have to synthesize all the information collected and render it according to the plan we have established.

BIBLIOGRAPHY

Brown, J. H., & Ojeda, R. A. 1987. Granivory: patterns, processes, and consequences of seed consumption on two continents. *Revista Chilena de Historia Natural*, *60*, 337-349.

Calviño-Cancela, María. 2007. « Seed and Microsite Limitations of Recruitment and the Impacts of Post-Dispersal Seed Predation at the within Population Level ». *Plant Ecology* 192 (1):35-44.

Clewell, A., Aronson, J., & Winterhalder, K. (2004). The SER international primer on ecological restoration. Ecol Restor, 2, 206-207.

Cristofoli, Sara, et Grégory Mahy. 2010. « Restauration écologique: contexte, contraintes et indicateurs de suivi ». Biotechnologie, Agronomie, Société et Environnement 14 (1):203.

Denham, Andrew J. 2008. « Seed Predation Limits Post-Fire Recruitment in the Waratah (Telopea Speciosissima) ». *Plant Ecology* 199 (1):9-19.

Dennis, A. J. (Ed.). (2007). Seed dispersal: theory and its application in a changing world. CABI.

Fox, C.W., W.G. Wallin, M.L. Bush, M.E. Czesak, et F.J. Messina. 2012. « Effects of Seed Beetles on the Performance of Desert Legumes Depend on Host Species, Plant Stage, and Beetle Density ». *Journal of Arid Environments* 80 (mai):10-16.

Gómez, Crisanto, Xavier Espadaler, et Josep M. Bas. 2005. « Ant Behaviour and Seed Morphology: A Missing Link of Myrmecochory ». Oecologia 146 (2):244- 46.

Gong, Hede, ChaoZhi Tang, et Bo Wang. 2015. « Post-Dispersal Seed Predation and Its Relations with Seed Traits: A Thirty-Species-Comparative Study: Seed Predation and Seed Traits ». *Plant Species Biology* 30 (3):193-201.

Grubb, P. J. 1977. The maintenance of species-richness in plant communities: the importance of the regeneration niche. *Biological reviews*, *52*(1), 107-145.

Holl, Karen D., et Megan E. Lulow. 1997. « Effects of Species, Habitat, and Distance from Edge on Post-dispersal Seed Predation in a Tropical Rainforest ». Biotropica 29 (4):459–468.

Honek, Alois, Zdenka Martinkova, Pavel Saska, et Stanislava Koprdova. 2009. « Role of Post-Dispersal Seed and Seedling Predation in Establishment of Dandelion (Taraxacum Agg.) Plants ». *Agriculture, Ecosystems & Environment* 134 (1-2):126-35.

Hulme, Philip E. 1998. « Post-dispersal seed predation: consequences for plant demography and evolution ». *Perspectives in Plant Ecology, Evolution and Systematics* 1 (1):32–46.

Lake, P.S. 2001. « On the maturing of restoration : linking ecological research and restoration ». *Ecological Management & Restoration*, 2(2): 110-115.

Lucas-Borja, Manuel E., Javier Madrigal, David Candel-Pérez, Enrique Jiménez, Daniel Moya, Jorge de las Heras, Mercedes Guijarro, José Antonio Vega, Cristina Fernández, et Carmen Hernando. 2016. « Effects of Prescribed Burning, Vegetation Treatment and Seed Predation on Natural Regeneration of Spanish Black Pine (Pinus Nigra Arn. Ssp. Salzmannii) in Pure and Mixed Forest Stands ». *Forest Ecology and Management* 378 (octobre):24-30.

Murillo, Natalia, Pedro Laterra, et Gloria Monterubbianesi. 2007. « Post-dispersal granivory in a tall-tussock grassland: A positive feedback mechanism of dominance? » *Journal of Vegetation Science* 18 (6):799–806.

Orrock, John L., Douglas J. Levey, Brent J. Danielson, et Ellen I. Damschen. 2006. « Seed Predation, Not Seed Dispersal, Explains the Landscape-Level Abundance of an Early-Successional Plant: Seed Predation and Large-Scale Plant Abundance ». *Journal of Ecology* 94 (4):838-45.

Paine, C.E.Timothy, et Harald Beck. 2007. « Seed predation by neotropical rain forest mammals increases diversity in seedling recruitment ». *Ecology*, 88(12): 3076-3087.

Roselli, S. M.2014. The role of seed dispersal, seed predation and drought in the restoration of Ngel Nyaki Forest, Nigeria.

Schowalter, Timothy D. 2016. « Chapter 13 - Pollination, Seed Predation, and Seed Dispersal ». In *Insect Ecology (Fourth edition)*, 445-76. Academic Press.

Severns, Paul M. 2008. « Seedling population size and microhabitat association in Lupinus oreganus A. Heller var. kincaidii CP Sm.(Fabaceae) a threatened plant of western Oregon grasslands ». *Native plants journal* 9 (3):358–365.

Shimamoto, C. Y., & Torezan, J. M. D. (2012). Seed removal in an Atlantic Forest fragment and a restoration site in southern Brazil. Remoção de sementes em um fragmento de Floresta Estacional Semidecidual e em um plantio de restauração no Sul do Brasil. *Revista do Instituto Florestal*, *24*(2), 201-209.

Thorsen, Michael J., Philip J. Seddon, et Katharine J. M. Dickinson. 2011. « Faunal Influences on New Zealand Seed Dispersal Characteristics ». *Evolutionary Ecology* 25 (6):1397-1426.

Turnbull, Lindsay A., Michael J. Crawley, et Mark Rees. 2000. « Are plant populations seed-limited? a review of seed sowing experiments ». *Oikos* 88 (2):225–238.

Wang, Bo, et Xiaolan Yang. 2015. « Seed Removal by Scatter-Hoarding Rodents: The Effects of Tannin and Nutrient Concentration ». *Behavioural Processes* 113 (avril):94-98.