Seed ecology and physiology: role in the resilience of grasslands

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Seeds
Ecological restoration

Key element for understanding the dynamics of ecosystem regeneration and evolution

Resilience = Resistance + Regeneration Capacity

Reference ecosystem
Trajectory of the reference ecosystem

Complexity or function
Other function

Grasslands natural / semi-natural

Environmental filters

Global species pool (PE)

= Internal PE e.g. seed bank

External PE

Species able to colonize the environment

Dispersion filter

Limited dispersion

Seed rain

Seed bank

Predation

Brazil – Campo rupestre

France – La Crau

Predation

Seed quality?

Poor seed bank

Feeble recolonization

Dispersion filter

Global species pool (PE)

External PE

Internal PE e.g. seed bank

Species able to colonize the environment

Dispersion filter

Limited dispersion

Seed rain

Seed bank

Predation?
1. Review of seed rain studies in grasslands worldwide (Arruda et al. 2018 – Restoration Ecology)

2. Estimate and compare Seed rain during 1 year
   - Species richness
   - Diversity
   - Composition

   Degraded and preserved areas

3. Estimate and compare Predation and removal of diaspores
   - Vertebrates exclusion
   - Control

   Degraded and preserved areas

4. Spatial variability of soil fertility + Mycorrhizal associations
   - Seed quality
   - Presence of embryo
   - Nutritional content
   - Viability

   (Dayrell et al. 2017)
How have we studied seed rain in grasslands and what do we need to improve for better restoration?
Unbalanced distribution of seed rain studies among grassland types calls for additional research efforts on non-temperate grasslands to better support restoration.
Conceptual Implications

• Significant knowledge gaps:
  (1) the role of native animals as seed dispersers
  (2) pre-dispersal and post-dispersal seed predation

• The lack of standardization of methodology, terminology and data reporting prevents a critical appraisal of the role of seed rain in restoration of grasslands

• Implementation of guidelines for methodology and data reporting, which will depend on future collaborative efforts
Campo Rupestre - Brazil

- 0.78% of the continental surface of Brazil
- 14.7% of the whole of Brazil vascular Flora (5011 species)
Degradation in Campo rupestre

Low resilience to some human actions

Mining

Urbanization

Le Stradic et al. 2018, Restoration Ecology
La Crau - France

Degradation in Coussouls

Agriculture
Search for seeds

Efficacy tests for sticky traps
Seed rain

+ 100 morphotypes
- Seeds identification

- **Positive relation between rainy months and the number of seeds captured** (water as a seed disperser)

- **The small number of seeds captured** indicate a close relation between the low resilience after as soil removal and **seed dispersal limitation**.
Seed removal and predation

Seeds:
Stryphnodendron gracile
Davilla elliptica

Fruits:
- Coccoloba cereifera
- Byrsonima cf. vacciniifolia
- Miconia irwinii

Artificial fruits:
Maizena, ground peanuts, hydrogenated fat, stain and sugar

- Post-dispersal removal can vary remarkably between diaspore types
- Invertebrates comprised the group that contributed most to seed removal
- Invertebrate activity significantly reduced in disturbed sites
- Even at low rate, Post-dispersal removal, could negatively affect vegetation regeneration, especially if seed rain in disturbed patches is limited
Seed quality

Edaphic gradient

% colonization of roots by mycorrhizae

P availability in the soil

Box plots comparing root colonization (% colonization of roots by mycorrhizae) across different vegetation types: Cerrado, Rock outcrop, Gravel sand, White sand. The plots show variability in P availability in the soil.
- High proportion of embryoless seeds in poor soils
- High phosphore/ carbone in poor soils

Hypothesis: P availability in the soil affects P content in the seeds.
Thank you for your attention
Root specializations for P absorption

- Primary mycorrhizal colonisers
- Arbuscular mycorrhizal
- Ectomycorrhizal
- Ericoid mycorrhizal
- Mycorrhizal with simple clusters
- Non-mycorrhizal with simple clusters
- Non-mycorrhizal with compound clusters
- Ancient, highly weathered

Acquisition strategy vs. Soil age

P\text{total} vs. Soil age

N\text{total} vs. Soil age

Quantity of major nutrients

Poorly developed, very young

TRENDS in Ecology & Evolution

Lambers et al, 2008