Learning, tools and pitfalls of agroecology at landscape scale.
Lessons from projects in DYNAFOR Lab.

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Quels outils pour un changement d'échelle dans la gestion des insectes d’intérêt économique?
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Contents

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1. Why changing scale?

Changing scale of observation = Changing the dominant phenomena controlling the pattern

Question: predator / Prey abundances at different sampling scales in forest leaf litter?

(Rose et Legget in Gergel & Turner, 2002)

- Insect sampling: abundance in 0.1 m² (grain)
1. Why changing scale?

Fine scale = predator avoidance

Grain = 0.1m\(^2\), Extent = 100m
1. Why changing scale?

Large scale = predator and prey have similar ecological requirements (leaf litter more abundant in forest area than in crop)

Grain = 10 m², Extent = 10 000m
1. Why changing scale?

Most of insect of economic interest are mobile: Pests & Beneficial insects (more or less…)

Predators, parasites, pollinators = MABES: Mobile-Agent-Based Ecosystem Services (sensu Kremen et al., 2007)
2. Learning from DYNAFOR Lab Project

We are not a « crop protection » Lab.

Studies at different scales:

Wood density

Emergence of beneficial insects (carabids and others) from woods and other semi-natural elements

Complex of beneficials insects = multi-scales?
2. Learning from DYNAFOR Lab Project: Wood density

How can woodlots contribute to crop protection?

By promoting natural enemies of pest (aphids)

Providing shelter (against cold or hot weather)

Being stable elements of rural landscapes (recolonisation of the landscape)

Providing resources (alternative preys and/or flowers)
Main Hypothesis:
Landscapes with higher woodlot cover provide a more efficient crop protection than less wooded landscapes.
The studied species

*Episyrisphus. balteatus* larva: one of the most efficient predator of cereal aphids

*E. balteatus* adult: - ubiquitous "flower fly" → nectar and pollen feeding
  - active females overwinter in southern Europe

The sooner aphidophagous insects set up in crops → the greater the chance to keep the aphids below damage level
Our questions

✓ Is there more *E. balteatus* and less aphids in wheat crops surrounded by woodlots?

✓ Do woodlots help winter survival & support early spring *E. balteatus* abundance?
Study sites

LTSER site Gascony Valleys & Hills

- Wooded: 27%
- Less wooded: 15%

Increasing wood density

- 5 km
6-7 Sampling of wheat stalk from April to June (2003 to 2007)
7 crop fields per landscape
1 sampling square (unsprayed) per field
10 bags of 10 stalks per squares

1 400 stalks per sampling date
A multi-agent model of winter survival was developed, on CORMAS platform (Arrignon et al. 2007).

It predicts the abundance of hoverfly at the end of the winter, according to:
- Winter temperature,
- Landscape composition and structure,
- Individual behaviour.

The Hover-Winter model

Results: No significant difference between wooded & non wooded landscape for hoverflies (eggs & larvae)

A significant year effect (P<0.01)
ANOVA: co-variable: aphids, A significant effect of the year (P<0.01)

* The fourth first sampling (~April-May)
Results: An hoverflies / aphids ratio not always greater in wooded landscape......
Results: A positive effect of wooded landscape for winter (simulation) not always confirmed by early spring abundance in the field.
Back to the questions

✔️ Is there more *E. balteatus* and less aphids in wheat crops surrounded by woodlots?

Yes, in early spring only, then they are everywhere whatever the landscape

A threshold of 30% of woodlots in the landscape seems necessary to get the early spring effect.
Back to the questions

✅ Do woodlots help winter survival & support early spring *E. balteatus* abundance?

Sometimes yes, in addition to flower patches (meadows, hedges) in the vicinity.

The complementation between woodlots & flower patches in the landscape seems necessary to improve winter survival of adult females.
What is the spatial distribution of overwintering field ground beetles in woodlots regarding:

the distance from the edge?

2. Learning from DYNAFOR: Emergence of beneficial insects

Upper recipient for flying insects

Pitfall trap for walking insects

Walls buried into the soil

Total area: 1.8 m²
2. Learning from DYNAFOR: Emergence of beneficial insects

- 11 ha woodlot
- 45 emergence traps
- Placed relatively to:
  - Distance from edge (0 m; 25-50 m; >75 m)
- Traps activated from March to October 2008
2. Learning from DYNAFOR: Emergence of beneficial insects

- **2014 ground beetles** collected, from **48 species**
2. Learning from DYNAFOR: Emergence of beneficial insects

- Higher density in edges, whatever the adult habitat
- During spring, 2/3 of individuals trapped in edges belong to open habitat species
2. Learning from DYNAFOR: Emergence of beneficial insects

Feeding mode of adults:
- Predatory  n=1374  s=18
- Polyphagous  n=429  s=4
- Phytophagous  n=100  s=7
2. Learning from DYNAFOR: Emergence of beneficial insects

32 emergence traps in woods, hedges, grasslands and crops
2. Learning from DYNAFOR: Emergence of beneficial insects

- Beneficial carabids

**Graph:**

- **Anchomenus dorsalis**
  - Crops: 0.8
  - Hedges: 0.2
- **Demetrias atricapillus**
  - Wood edges: 1.0
  - Grasslands: 0.0
2. Learning from DYNAFOR: Complex of beneficial insects

ANR Systerra Landscaphid 2010-2013

Landscape suppressiveness on aphids
2. Learning from DYNAFOR: Complex of beneficial insects

Groupes d’auxiliaires considérés

Syrphes aphidiphages
- pupes et œufs

Chrysopes
- œufs

Entomophtorales

Coccinelles
- adultes, larves et œufs

Hyménoptères parasitoïdes
- momies pleines
2. Learning from DYNAFOR: Complex of beneficials insects

- Oeufs chrysopes ~ Surface friches

- Coccinelles adultes ~ Surface friches

But...
2. Learning from DYNAFOR Lab Projects

- Large scale … short temporal window
- Beneficial insect could be in the field itself during winter
- Large scale = multi-scales?
3. Pitfalls

✓ The aphid effect ..... (winter weather)

✓ Strong inter parcels variability

✓ Correlation of “woodenness” variable with management intensity on crops, presence of other semi-natural elements (hedges, field margins)
4. Tools & perspectives

- Modeling (Hover Winter: a model at fine scale to infer larger scale)
- Semi-controlled experiment with bait-pest (to control pest infestation) in GIS-conducted sampling design
- Landscape dynamics
- Identifying the right time and place
- Tropical landscape
4. Tools & perspectives

Spatial dynamics of a cotton pest moth *Helicoverpa armigera* in Western Africa to improve the use of ecosystem services.
Noelline Tsafack (PhD student, CIRAD)

Tools:
Microbial DNA
Isotopes (D, C, N)
Biochemical markers (Gossypol, Tomatine)

4 landscapes along a gradient of cotton crop density (landscape based sampling design), 5 cotton fields in each landscape (+ 1 landscape)

Question:
From where do the moths come from when they arrive in the cotton field (October)?

Long distance (migration)  Backyard
No or few landscape effect  Landscape effect (landscape analysis)
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