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Stéphanie Aviron, Chloé Vasseur, Sophie Puyo, Stéphanie Saussure, Jacques  
Baudry

► **To cite this version:**

Stéphanie Aviron, Chloé Vasseur, Sophie Puyo, Stéphanie Saussure, Jacques Baudry. Intra-annual heterogeneity of the cultivated mosaic: impact on carabid beetle populations. Colloque IALE world “landscape ecology for sustainable environment and culture”, Aug 2011, Pekin, China. pp.14. hal-01458577

**HAL Id: hal-01458577**

**<https://hal.science/hal-01458577v1>**

Submitted on 6 Jun 2020

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# Intra-annual heterogeneity of the cultivated mosaic: impact on carabid beetle populations

**Stéphanie Aviron, C. Vasseur, S. Puyo, S. Saussure, J. Baudry**

INRA, SAD-Paysage, Rennes, France

*Contact : clo.vasseur@gmail.com*



# Background



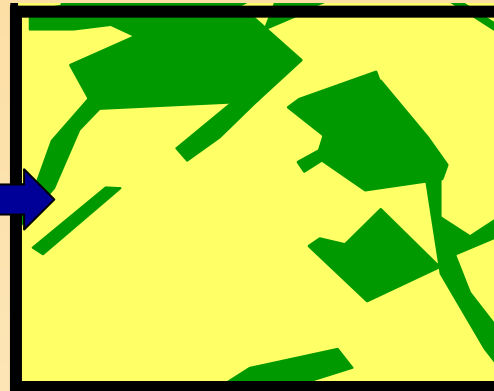
- **Conservation biological control** is proposed as an alternative to pesticide use against crop pests.



- **Enhancing biological control** requires to understand how local and landscape factors influence populations of natural enemies.

# Introduction

## Landscape heterogeneity for biodiversity



Amount of **semi-natural habitats** vs. cultivated matrix.

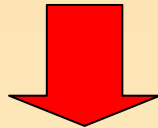


**Heterogeneity of the cultivated mosaic:** relevant for species which use crops during their life cycle.

# Introduction

## Intra-annual heterogeneity of the cultivated mosaic

### Crop cover states



### Mosaic of crop cover states



□ Bare soil

■ Dense cover

- **Changes in habitat quality** (crop growth, farming practices).
- **Asynchronous availability of resources** (timing of sowing and cultural interventions).

- **Changes in the spatial distribution of habitats** (mosaic of local dynamics induced by crop growth and practices).

# Question

## Impact of intra-annual heterogeneity of the cultivated mosaic on populations of natural enemies ?



Effect on the local dynamics (field and adjacent landscape elements) of carabid beetles  
Model species : *Pterostichus melanarius* Ill.

- **Generalist predator**, potential role for the control of crop pests
- **Adults:**
  - Dense vegetation covers: field margins in winter, active in crops from spring to autumn (foraging, breeding)
  - Limited dispersal ability (apterous).
- **Larvae:**
  - Overwintering and development in the soil of crops
  - Sensitive to soil disturbance (timing of tillage in crops)

# Hypotheses

- **Carabid activity-density (population level) in crops changes according to changes in crop covers:**

→ Increases with vegetation growth, decreases after harvest.

- **These changes are linked to carabid movements between crops:**

→ From unsuitable, reduced covers (crop newly sown or harvested) to suitable, dense crop covers.

- **These changes are also linked to carabid movements between crops and field margins:**

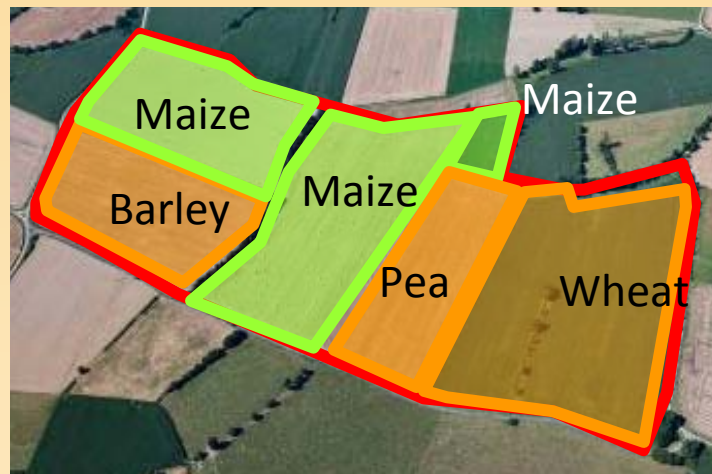
→ From field margins to suitable crop covers in spring (overwintering adults), and from unsuitable crop covers to field margins later (refuge).

# Methods : Field study

## Extensive survey of carabid populations in a “micro-landscape”



Brittany  
(France)



### Study area (30 ha):

Mosaic of crops on 6 fields  
and their margins.

Insect movements with  
surrounding fields supposed  
to be limited (roads, ditches)

### Different crops with different cover states during carabid activity period:

- **Maize**: from bare soil in spring to dense vegetation cover in late summer, harvest in late autumn.
- **Wheat, barley and pea**: dense vegetation cover in spring, and reduced cover after harvest in mid-summer.



# Methods : carabid sampling

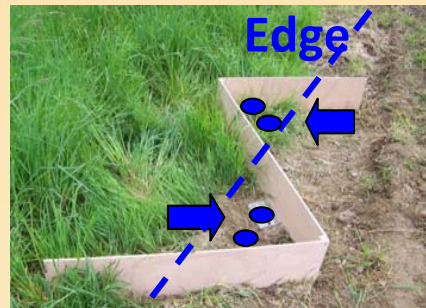
Continuous sampling from May to September



**Activity-density:**

Open traps (2 pitfall traps)

5 open traps / crop.



**Carabid movements:**

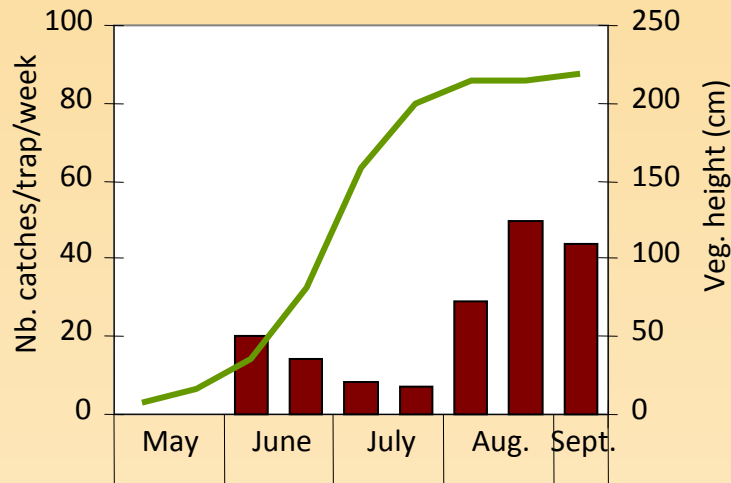
Bidirectional traps at edges between crops, and between crops and field margins.

2 bidirectional traps / edge.

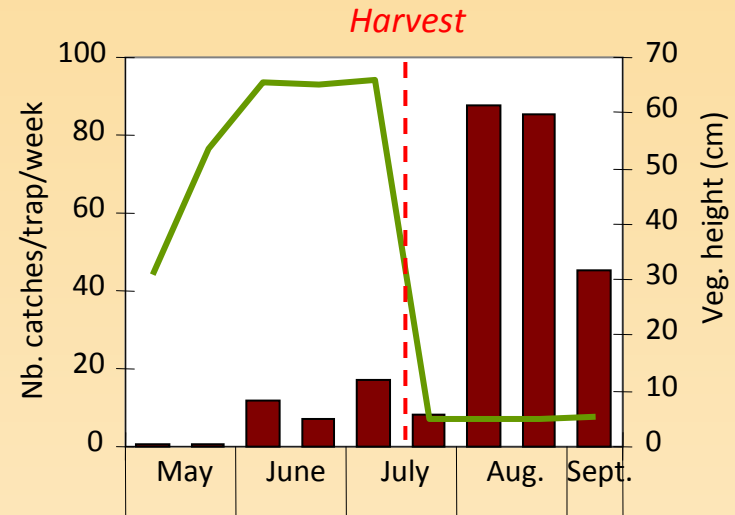
Monitoring of cover states : vegetation height, crop stage.

# Results – Activity-density of carabid beetles

## Activity-density and vegetation growth in maize



## Activity-density and crop harvest : ex. of pea

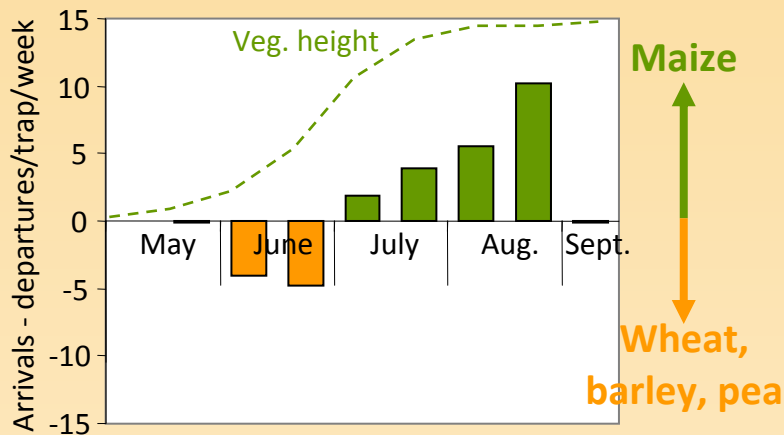


■ Activity-density    — Veg. height

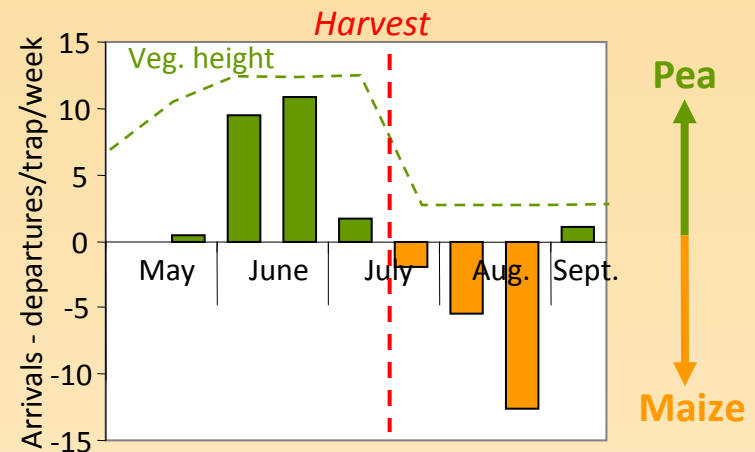
- **Vegetation growth in maize:** non negligible peak in early summer in spite of reduced cover, high activity-density when cover is developed
- **Crop harvest in pea:** low activity-density in early summer, in spite of dense cover, higher activity-density after crop harvest !

# Results – Carabid movements between crops

## Movement orientation at edges between maize and other crop types



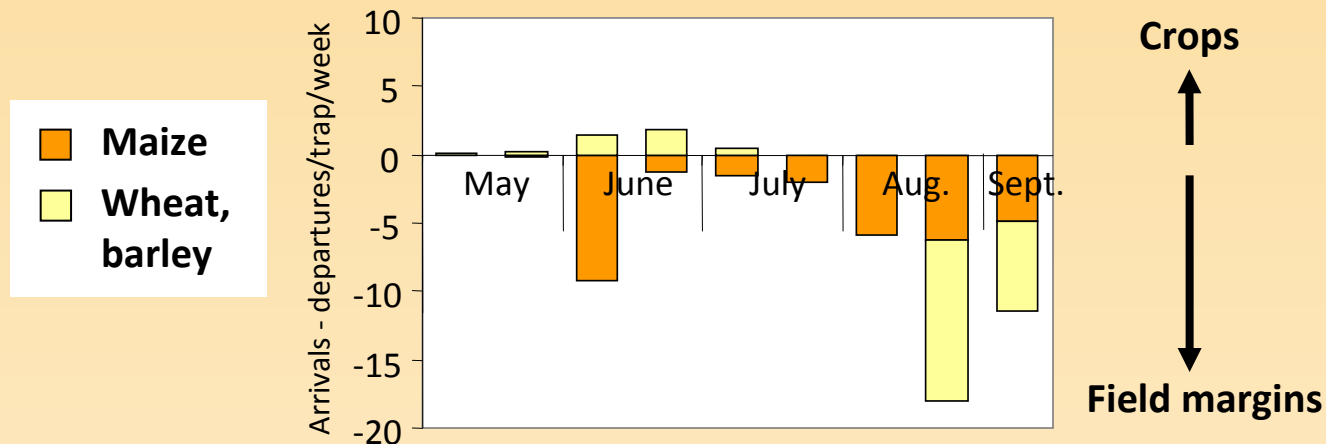
## Movement orientation at edges of harvested crops : ex. of pea



- **Maize edges:** movements from maize fields to adjacent dense crop covers in early summer, in late summer colonisation of maize where vegetation is developed.
- **Pea edges:** colonisation of pea (dense cover) from adjacent maize in early summer, movements from pea to adjacent maize after pea harvest.

# Results – Carabid movements between crops and field margins

## Movement orientation between crops and field margins



- **Maize edges:** no colonisation from field margins, movements from maize to field margins during the whole study.
- **Edges of barley and wheat:** limited colonisation from field margins, movements from crops to field margins in the late summer.

# Summary

- **No visible effect of crop cover changes (vegetation growth, harvest) on carabid activity-density in crops**
  - *High activity in unsuitable covers (starvation, exposure to predators) leading to more catches?*
- **Movements of carabid beetles from unsuitable to suitable crop covers during the whole study**
  - *Role of refuge played by suitable crop covers, habitat complementation between different crop types ?*
- **Carabid movements mostly oriented from crops to field margins**
  - *Role of refuge played by margins of unsuitable crop covers, or mass effect (high population levels in crops)?*

# Conclusion

- **Within a year, the asynchronous changes in crop cover states (and resources) are likely to affect some of the local processes involved in carabid population dynamics.**
- **Semi-natural habitats are important for carabid beetles, but the effect of the spatio-temporal heterogeneity of the cultivated mosaic should be investigated.**

# Thank you

## Acknowledgement

Field and laboratory assistants: C. Juhel, L. Meneau, M. Mille, C. Puech, J.L. Roger

Grants: INRA, Region Bretagne, CAREN, ANR Project *Biodivagrim*.

