Influence of farming system on ground beetle communities at local and landscape scales

Maud Belhache, El Aziz Djoudi, Stéphanie Aviron, Julien Pétillon, Manuel Plantegenest

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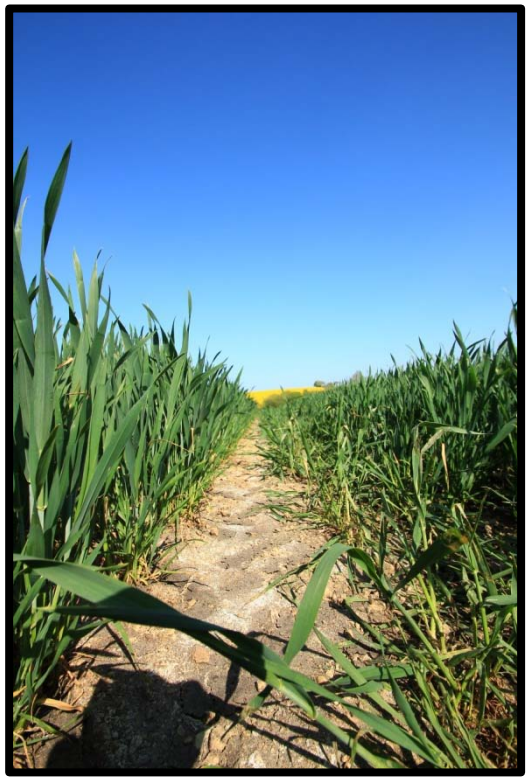

UMR 1349 INRA-Agrocampus Ouest-Université Rennes, IGEPP

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Context

- Needs for more **sustainable** and **healthy** agricultural systems

- **Development of Organic farming**

  → based on ecological processes

  → no petrochemical fertilizers and pesticides used

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Beneficial effect on the **abundance** and **species richness** of **ground beetle communities**.

How does organic farming affect ground beetle communities at local and landscape scales ?

Context

- **Differences in abundances and species composition (richness)**

Organic farming

\+ Abundance
Species richness

\-

Conventional farming

Context

- Differences in abundances and species composition (richness)

  ↳ **local scale processes**

Environmental characteristics

Organic farming

Resources
Constraints

Reproduction
Survival

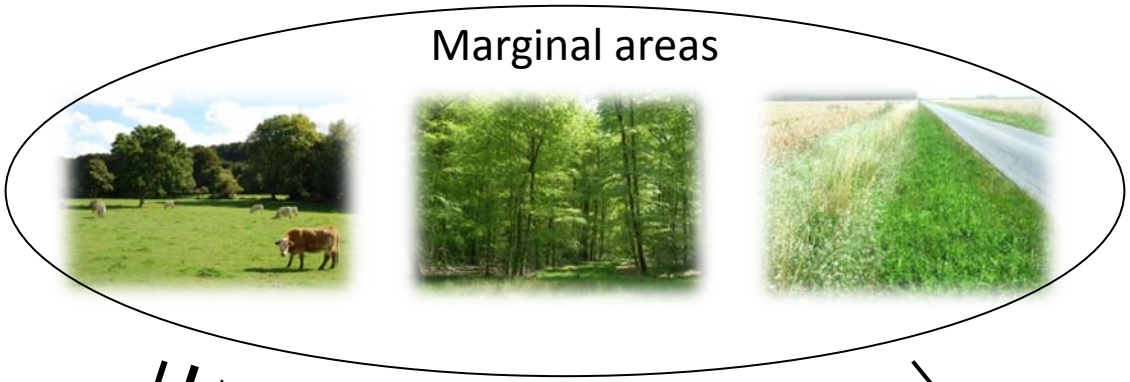
Conventional farming

Differences in species abundances and composition

Context

- Differences in abundances and species composition (richness)

  ↳ **landscape scale processes**



Organic farming

Immigration process

Differences in attractivity

Conventional farming

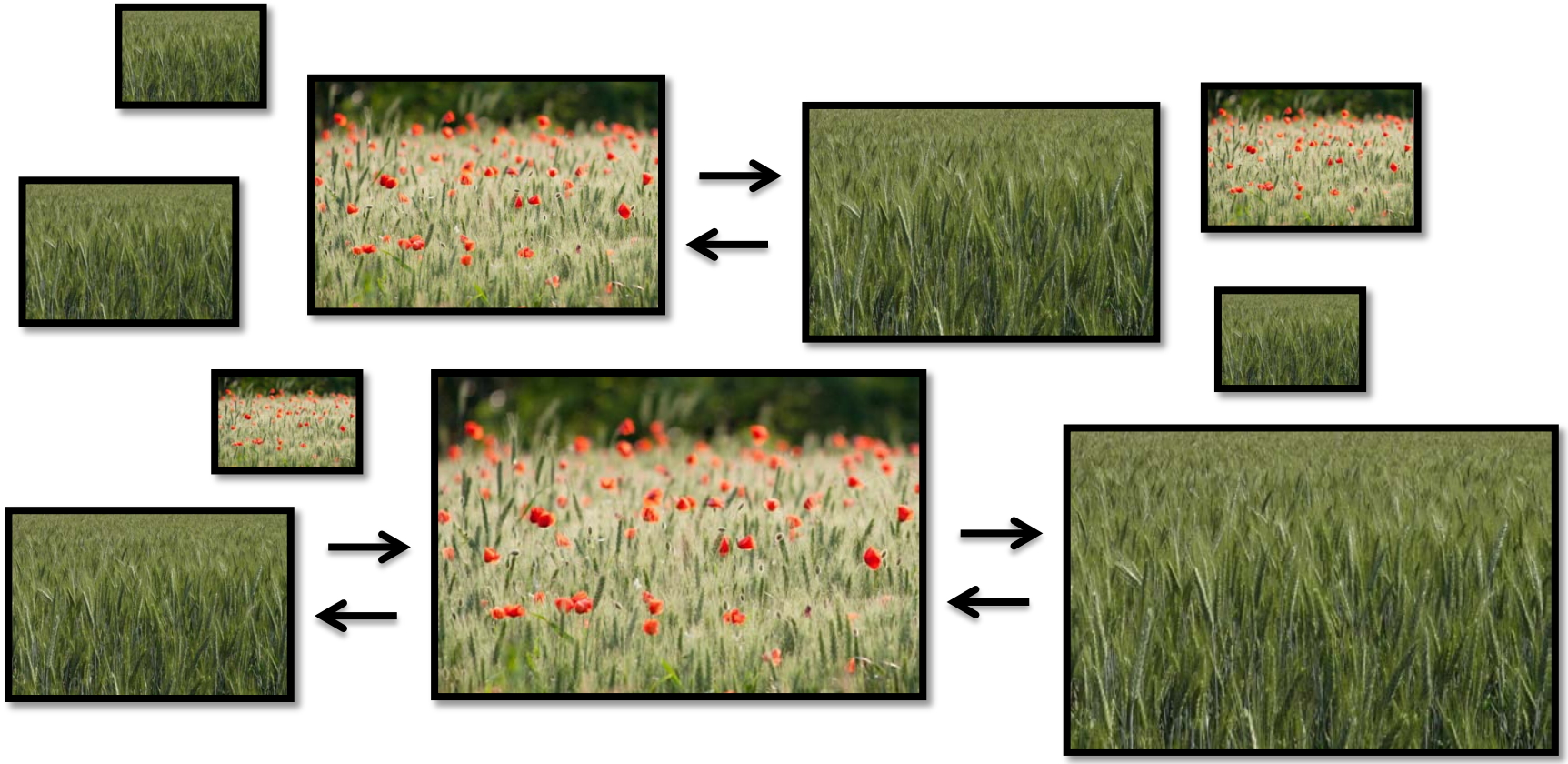
Context

- Differences in abundances and species composition (richness)
  - ↳ landscape scale processes : **coexistence of the two systems**

Context

- Differences in abundances and species composition (richness)

  ↳ landscape scale processes : **Source/Sink dynamics ?**



Influence of the proportion of organic farming at landscape scale ?

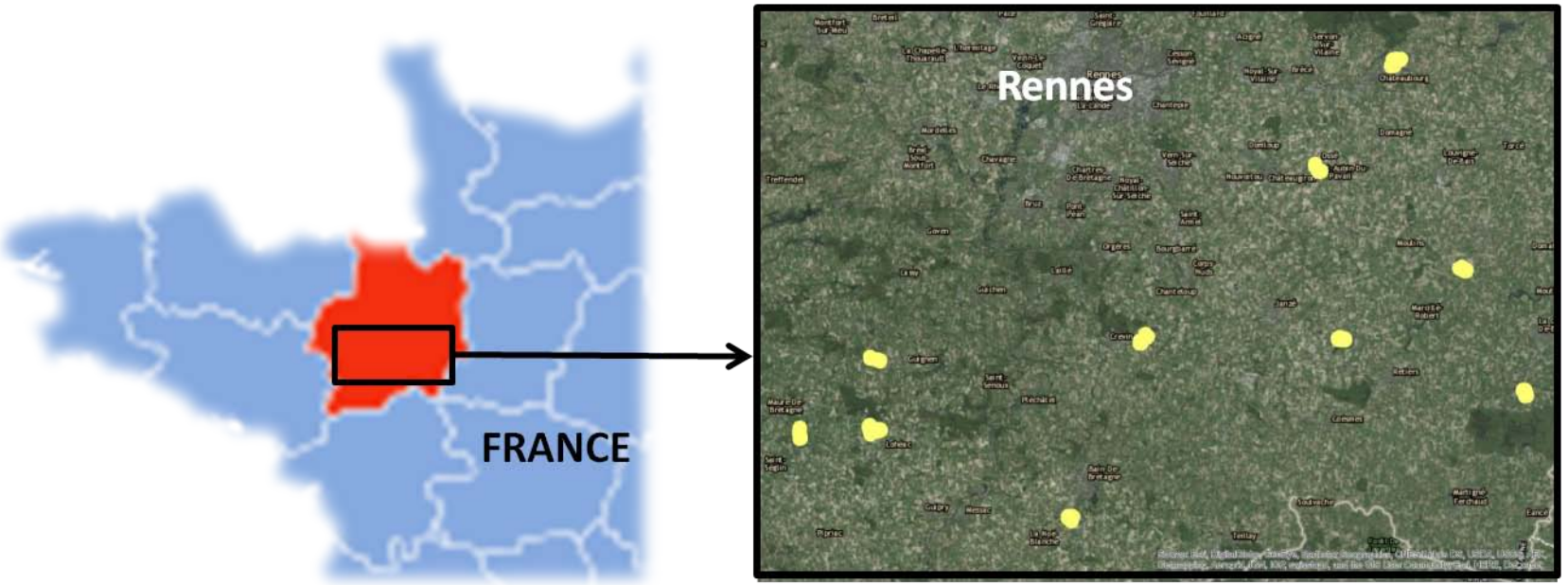
Goal and hypotheses

How does organic farming affect ground beetle communities at local and landscape scales ?

- Contrasting assemblages in organic *vs* conventional farming
  - ↳ habitat characteristics differ between systems
- Contrasting emerging *vs* circulating communities
  - ↳ local vs landscape contribution
- Assessing landscape influence on local communities
  - ↳ source/sink dynamics

Method

❖ Study site

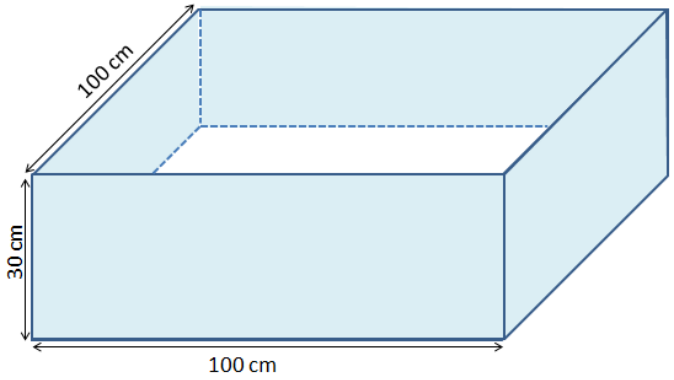


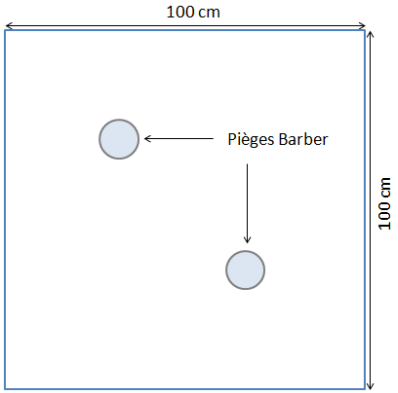
Selection of :

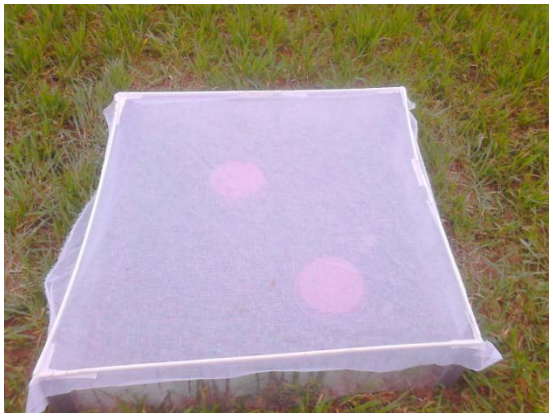
- ➢ 10 landscapes in Brittany
  - ↳ 20 wheat fields
    - → 10 under organic farming
    - → 10 under conventional farming

Method

❖ Experimental device

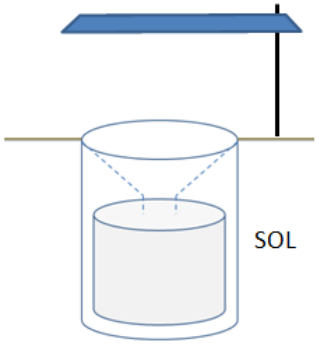






Emergence arena

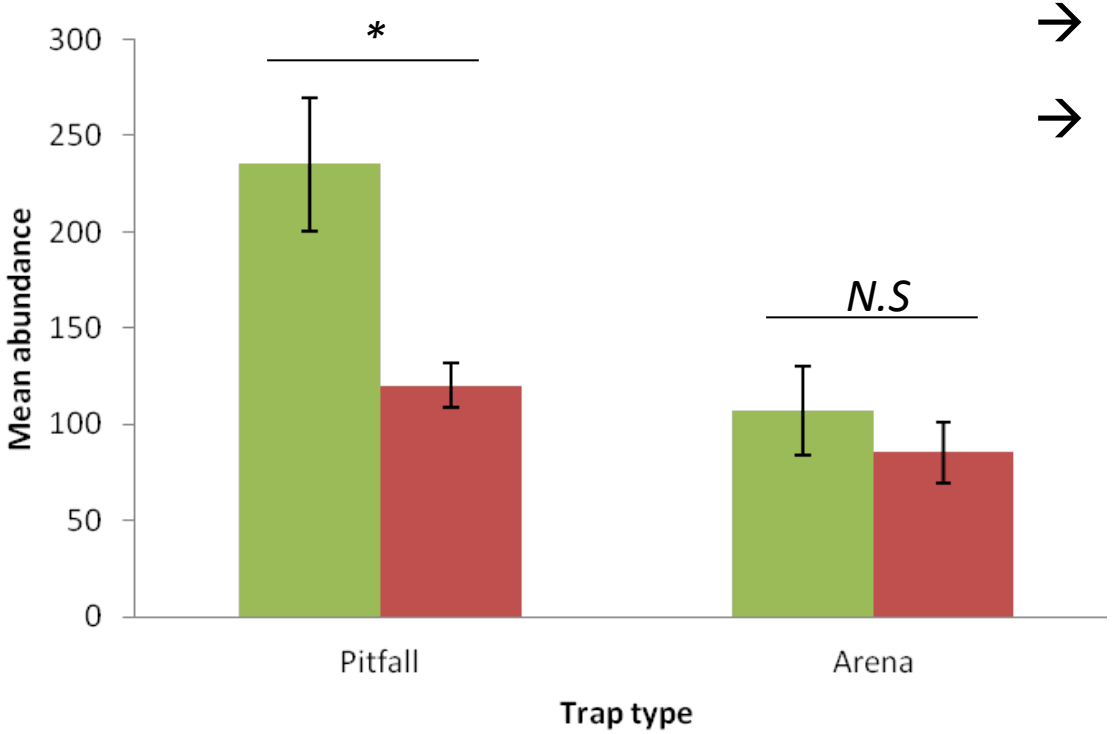
- In each sampled field :
  - → 3 emergence arenas including two pitfall traps
  - → 1 pitfall trap located in the vicinity of each emergence arena
- Samples collection every 2 weeks (april-may 2015).



Pitfall trap

Results : Local scale

❖ Abundances



N.S : nonsignificant difference ; * : P<0.05
green : OF and red: CF

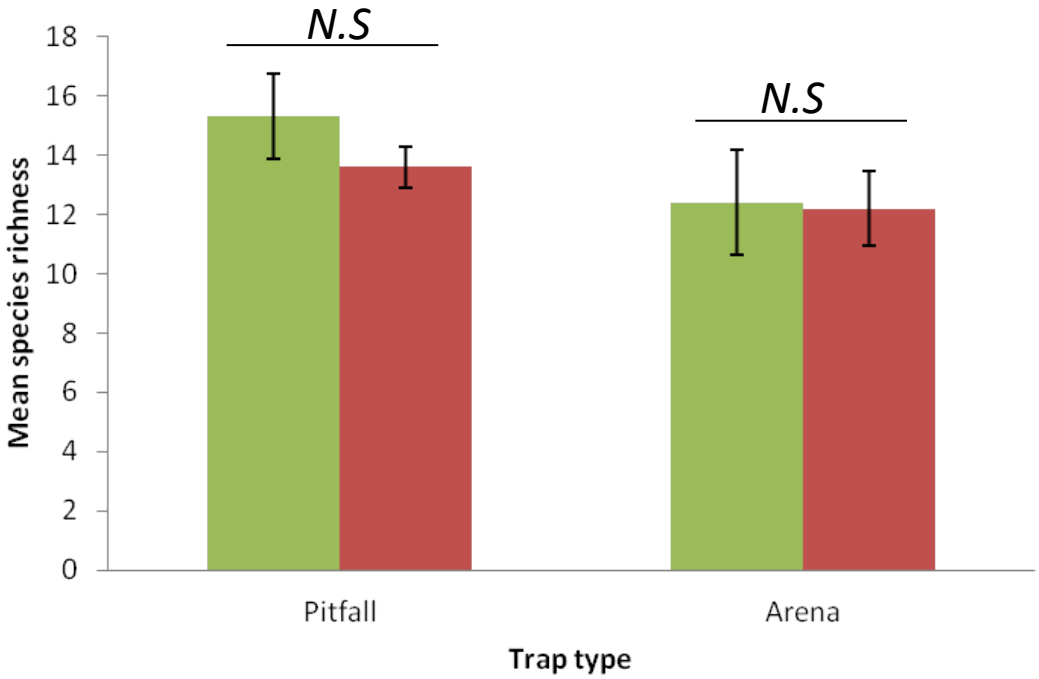
Higher abundances in OF :

→ attractive effect ?

→ differences in mortality rates ?

Results : Local scale

❖ Species richness



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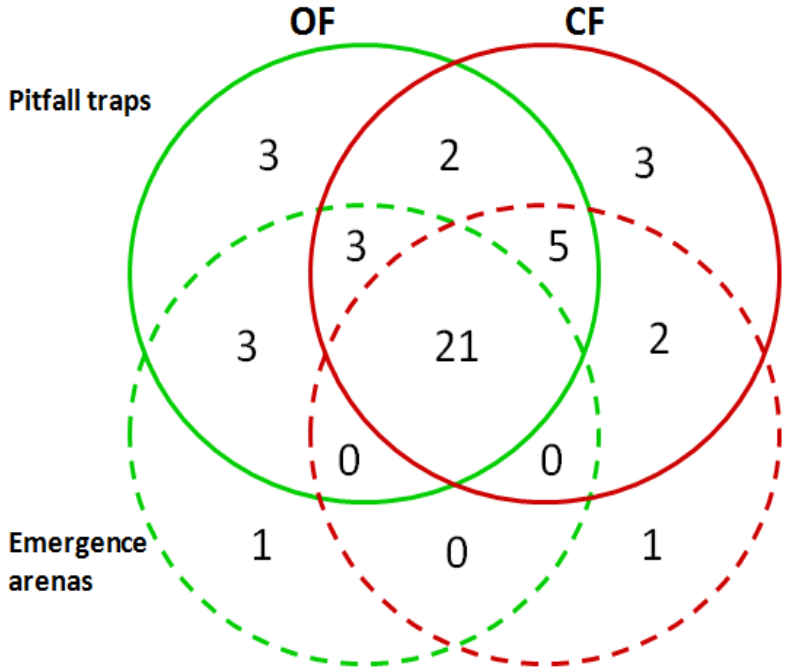
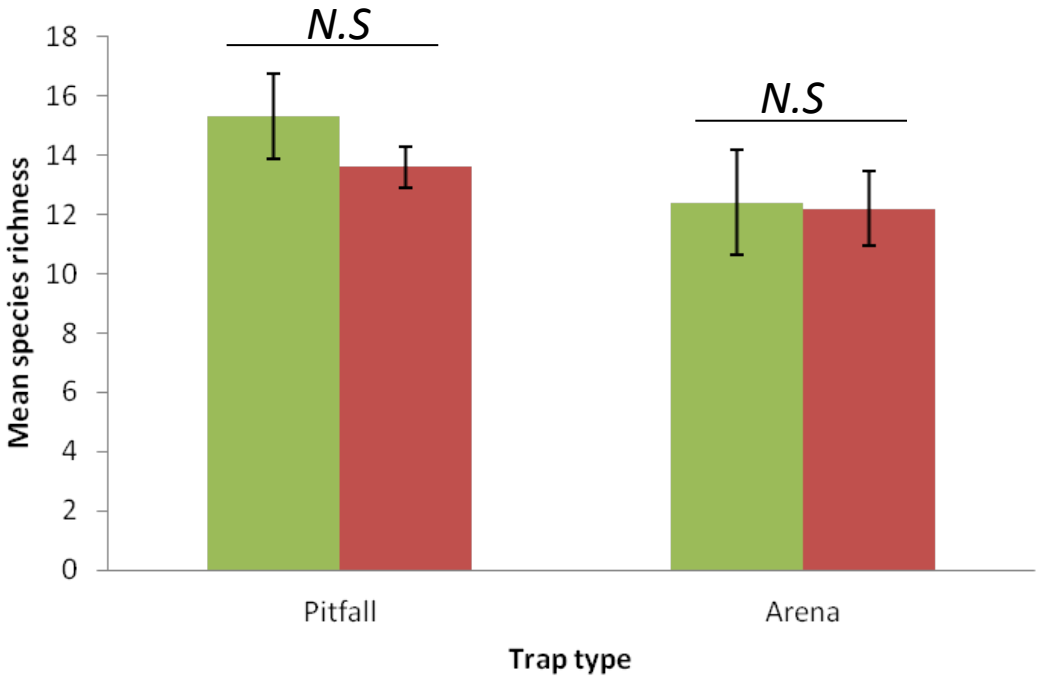


Total = 44 species

➢ Similar species richness in the two systems.

Results : Local scale

❖ Species richness



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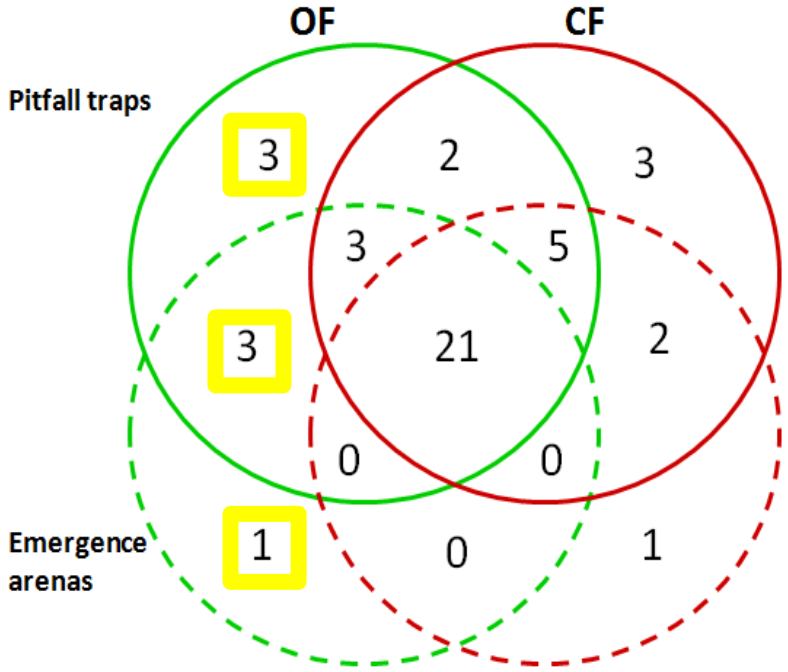

Total = 44 species

- Similar species richness between the two systems.
- Variation in communities composition.

Results : Local scale

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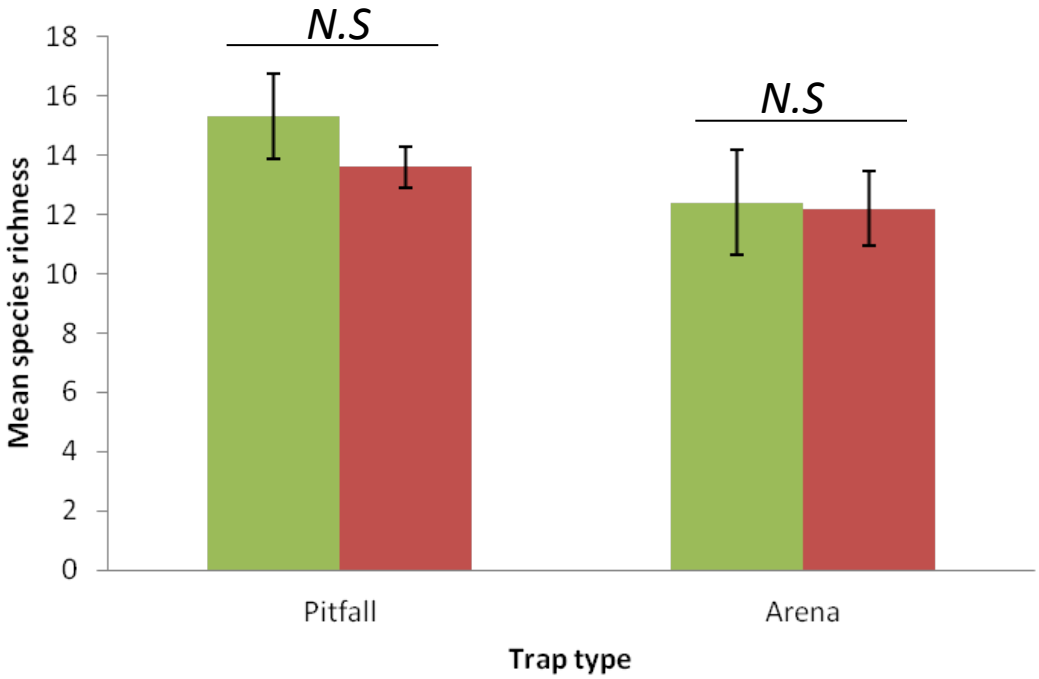

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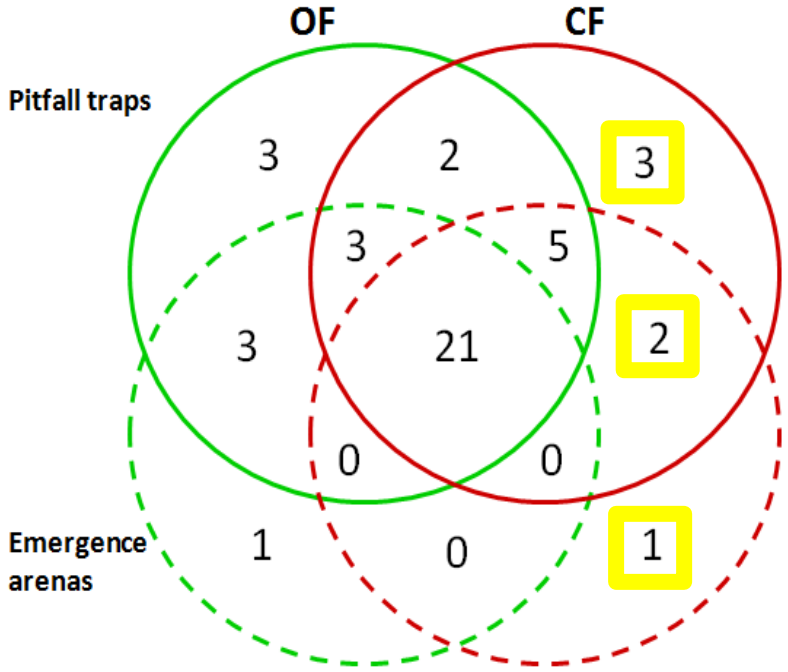

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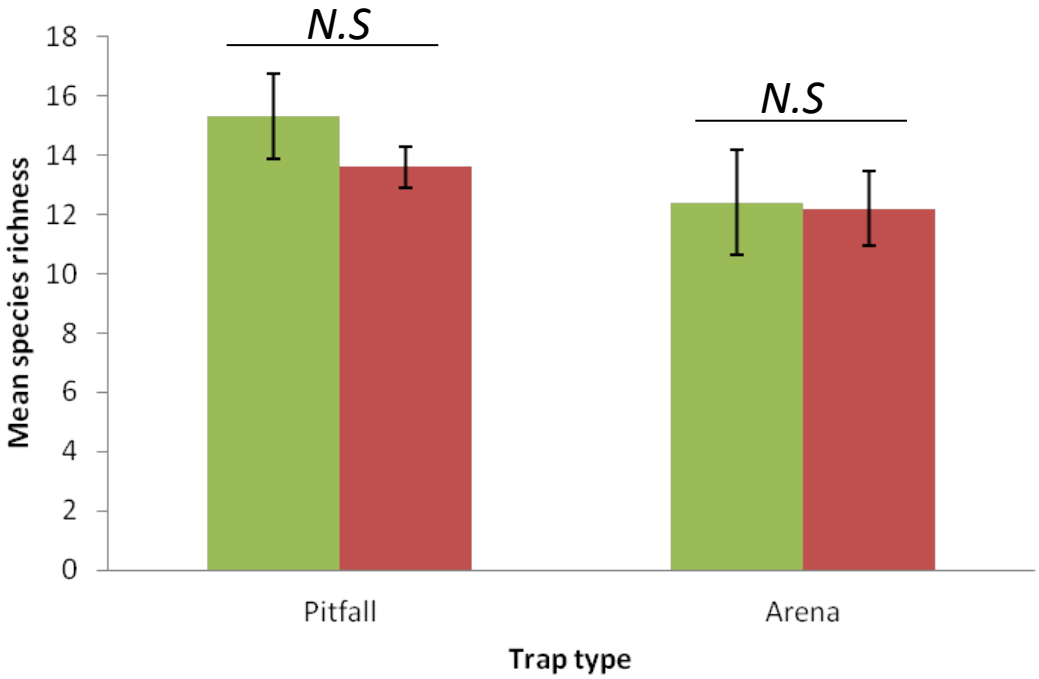

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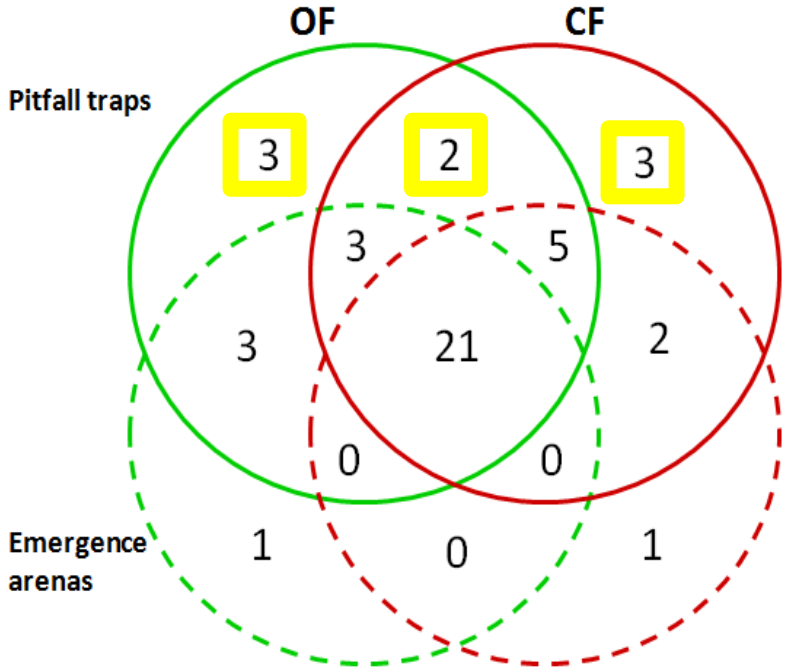

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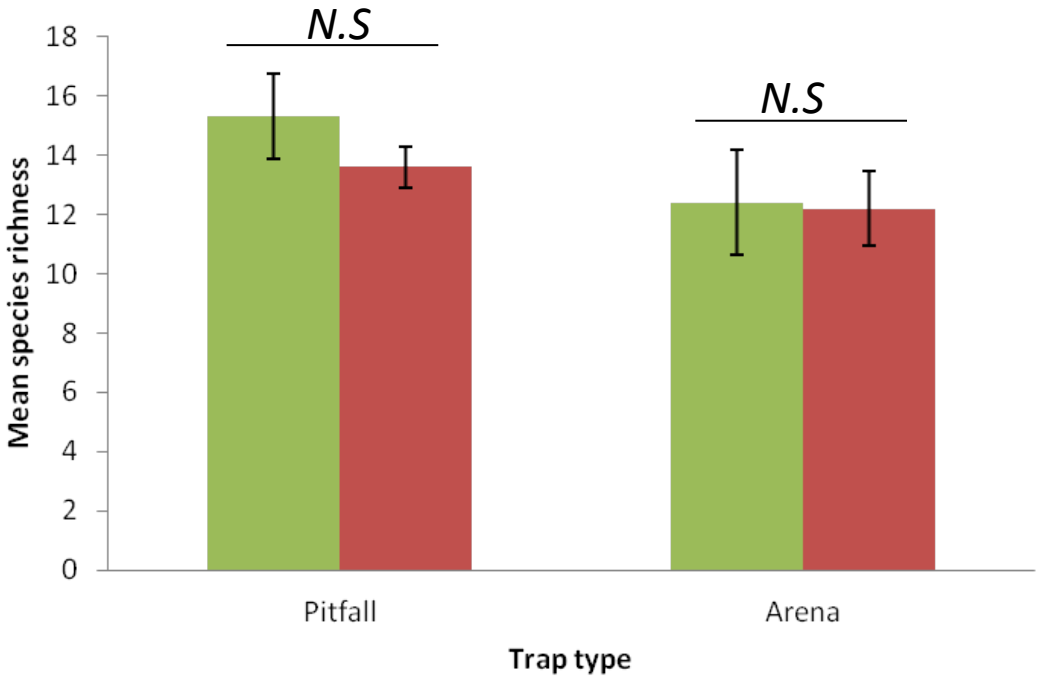

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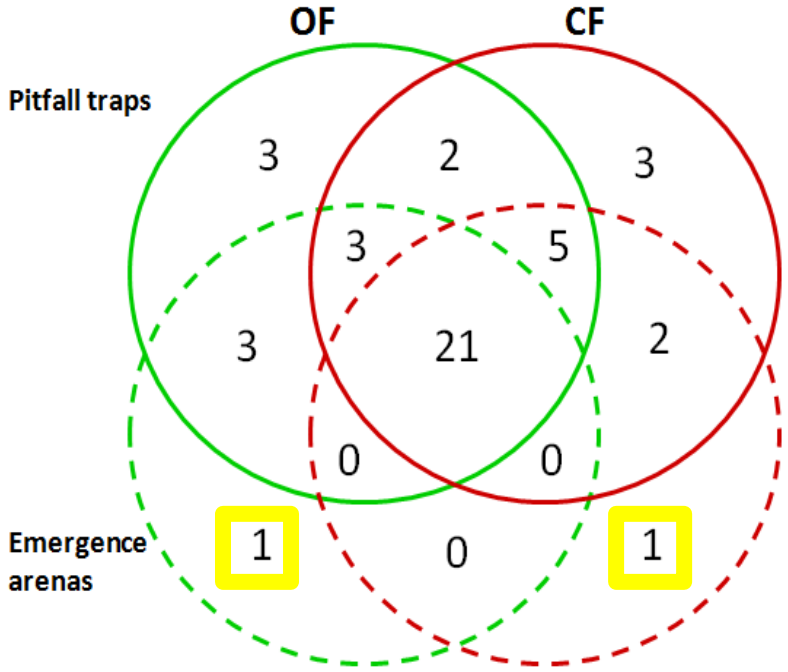

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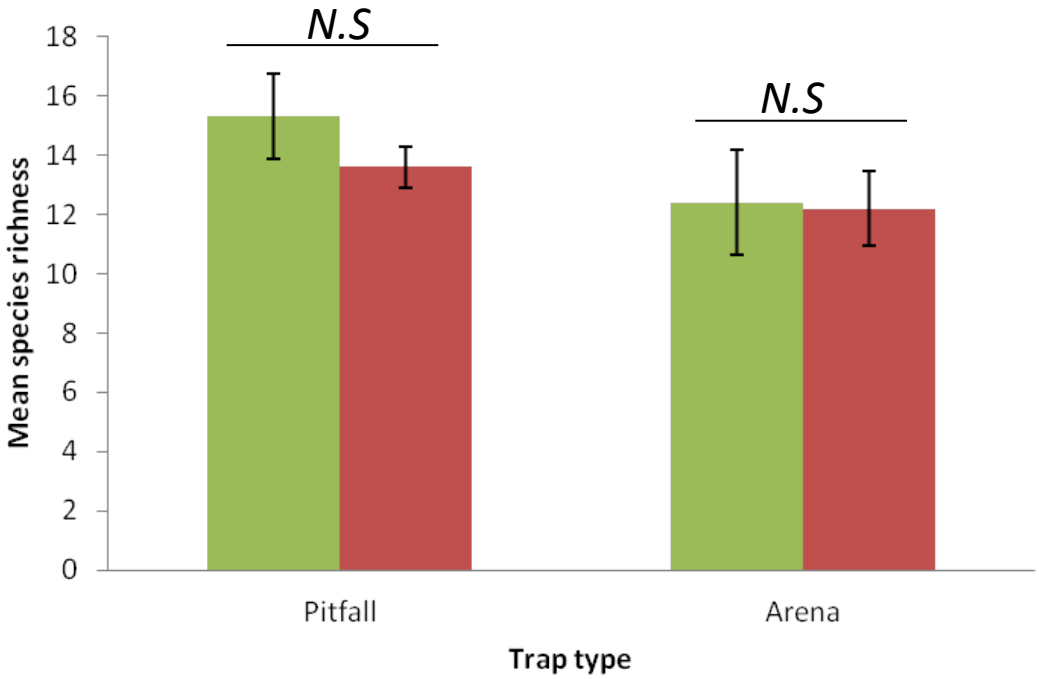

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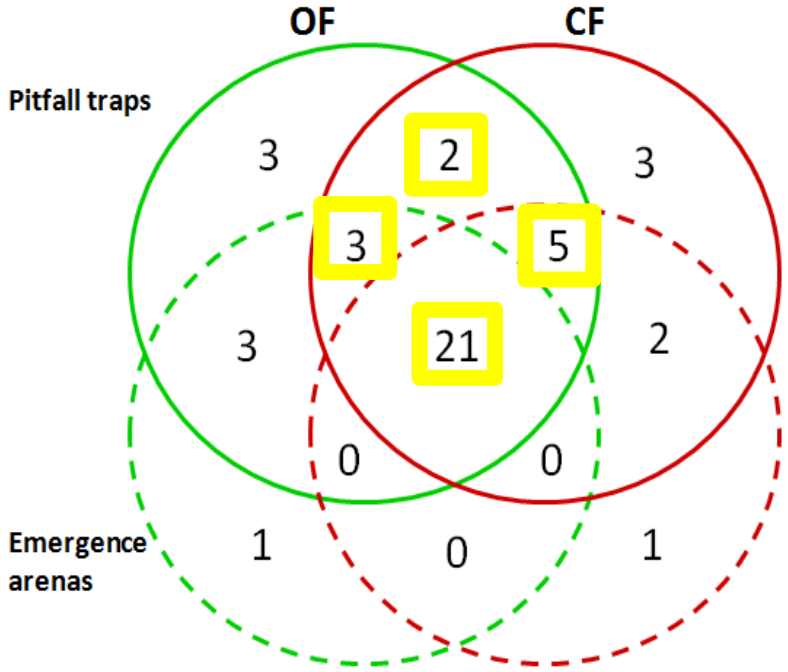
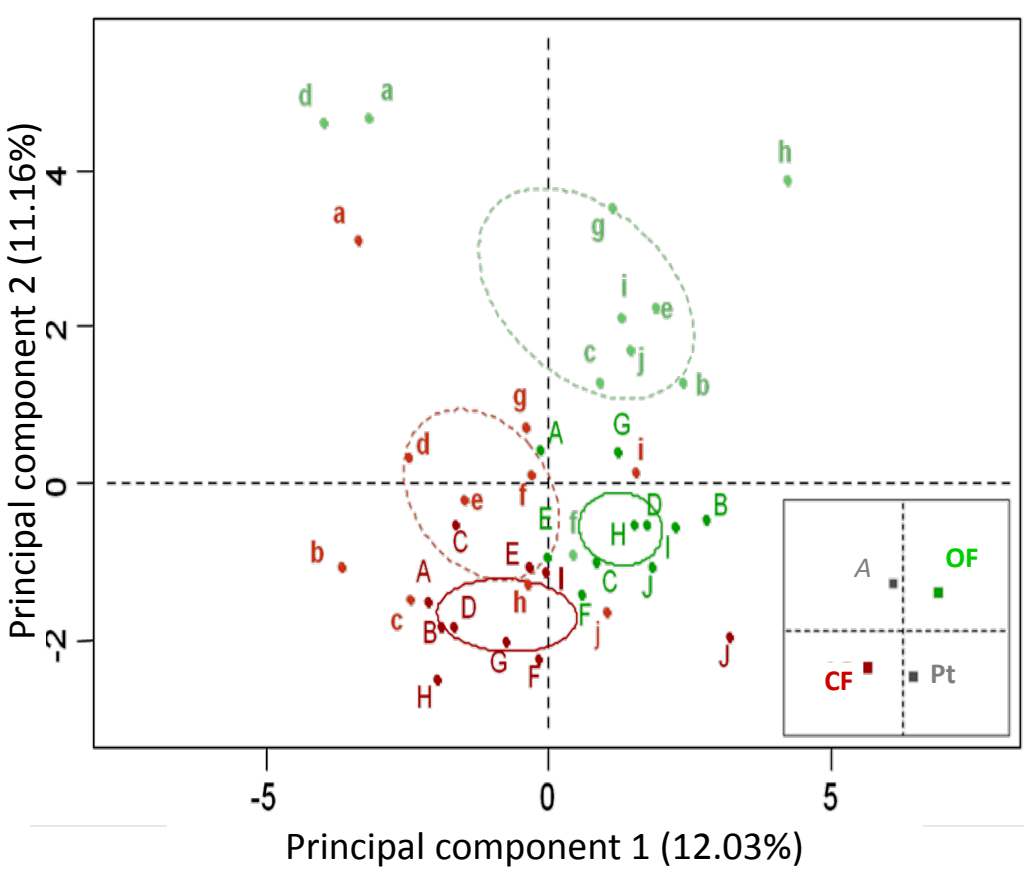


Total = 44 species

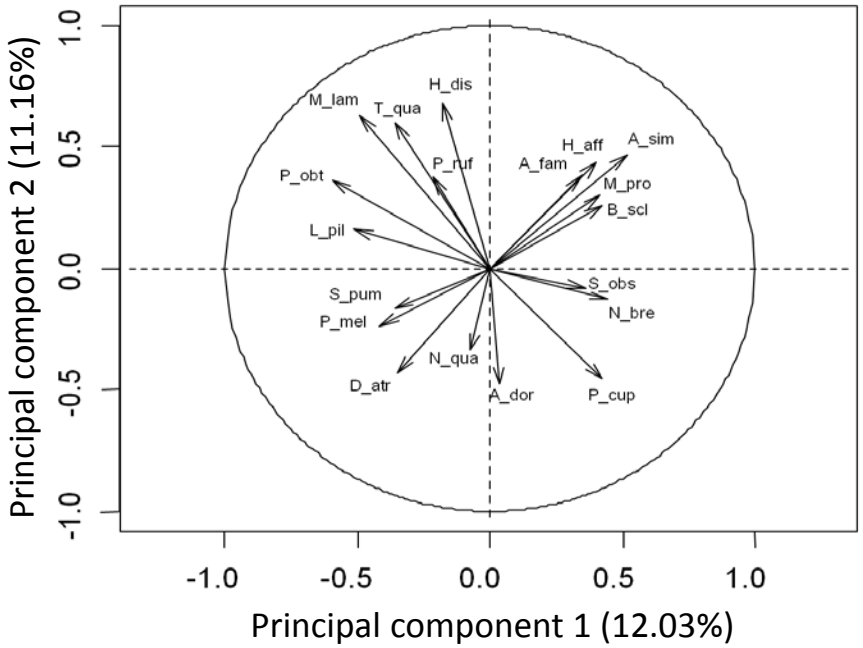
- Similar species richness between the two systems.
- Majority of species are present in the two systems.

Results : Local scale

❖ Specific composition of ground beetle communities



PCA : **species proportions** captured in both trap types during the entire sampling period.



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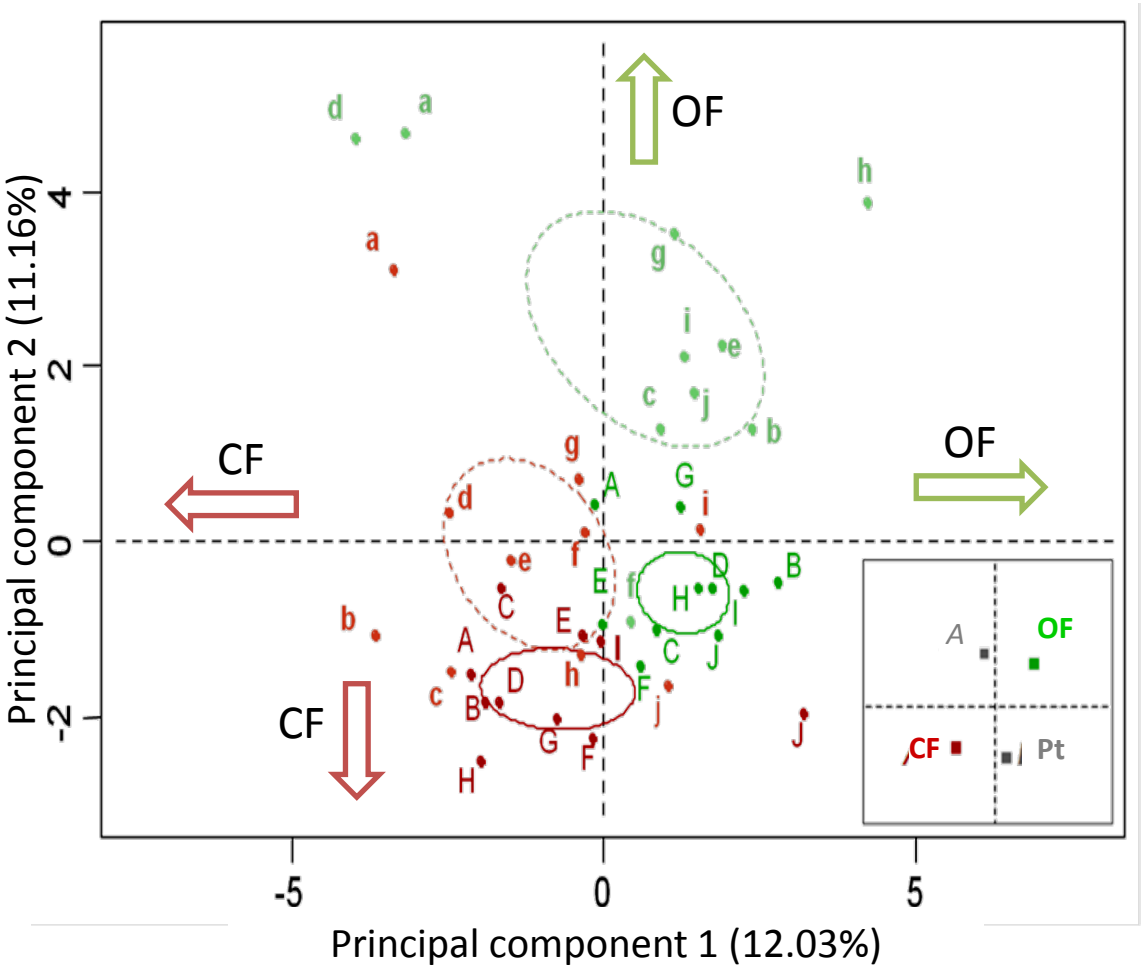

Axe 1 & 2 :
organic and conventional communities differ

Results : Local scale

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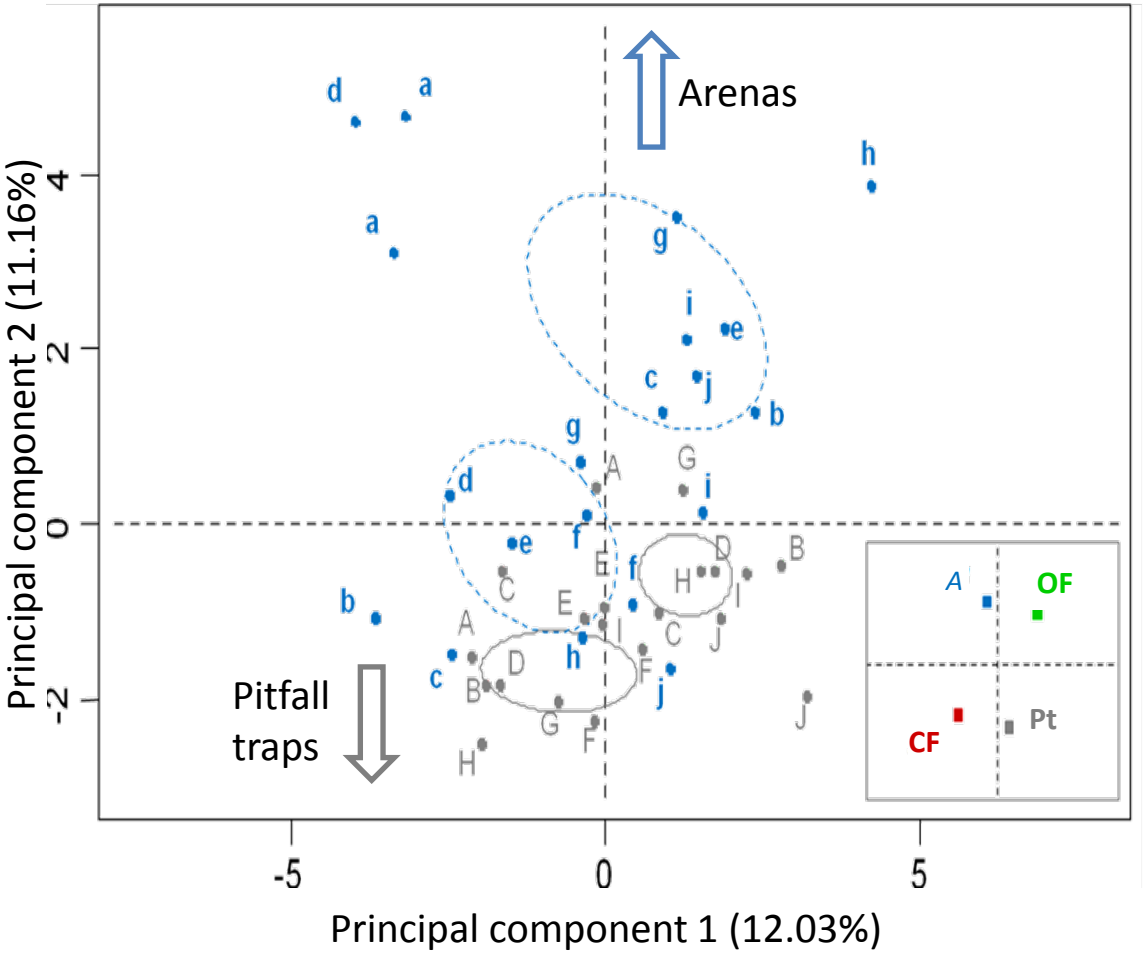

Axe 2 :
circulating and emerging communities differ

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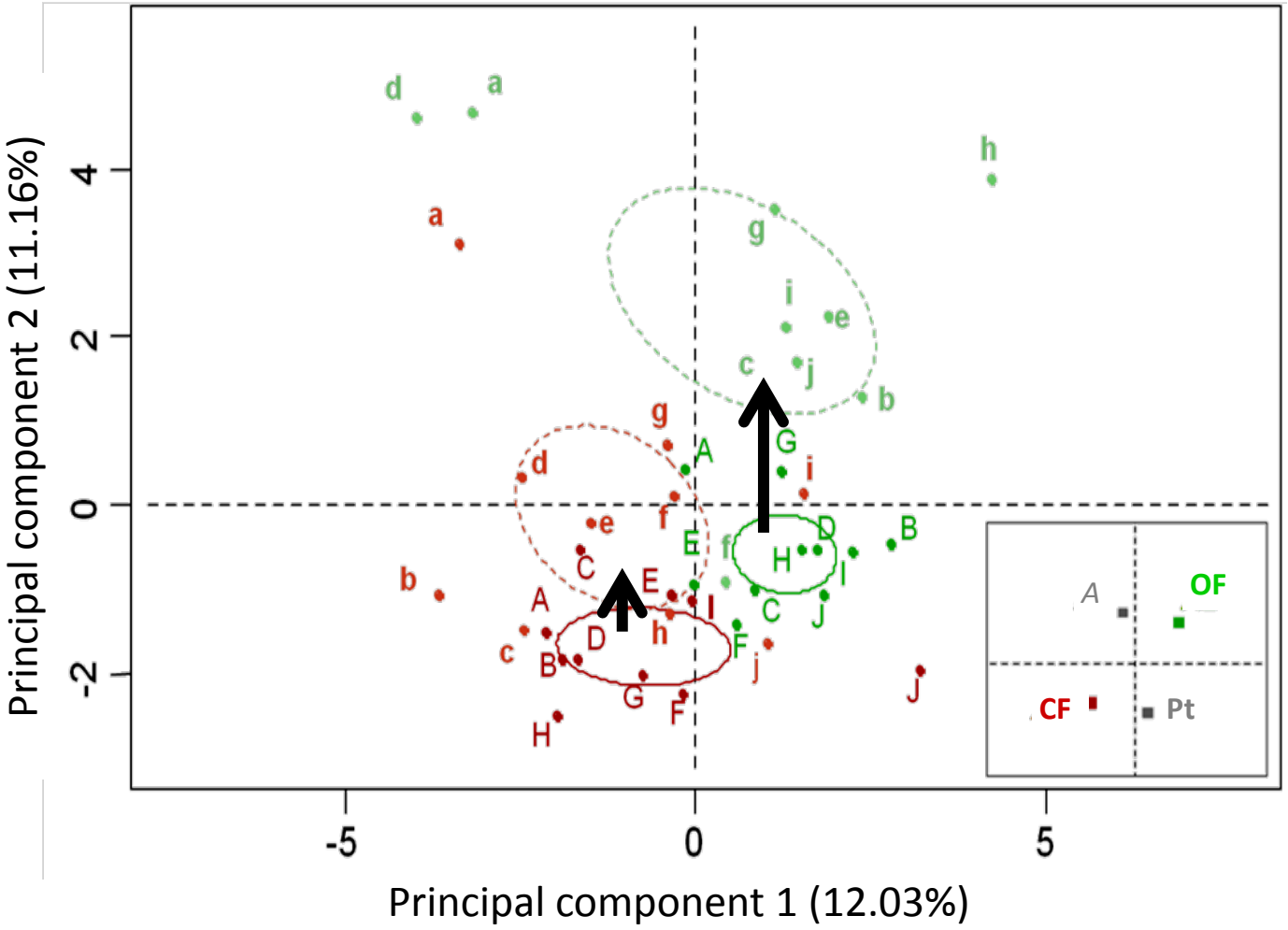

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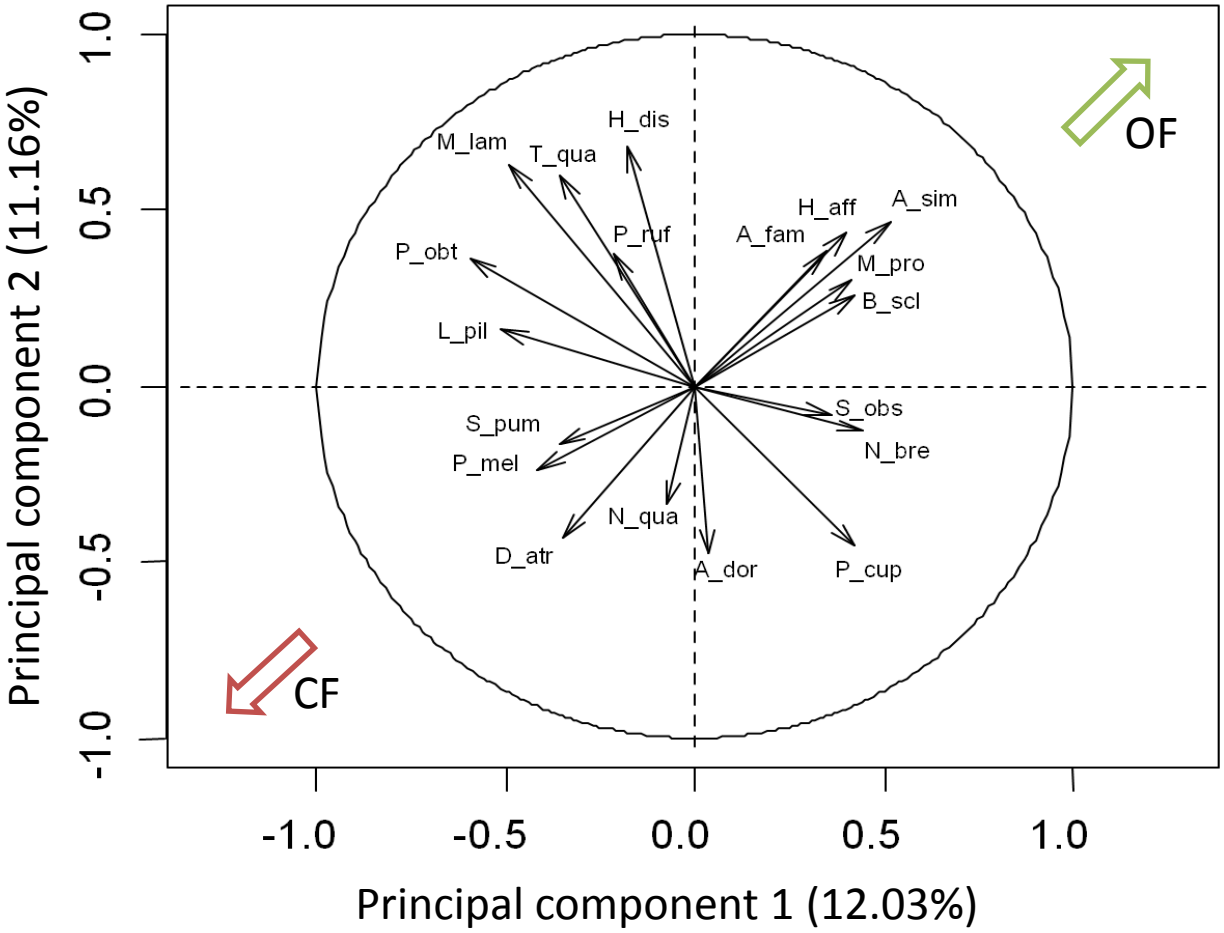

Organic farming :

- Rich vegetation cover

Results : Local scale

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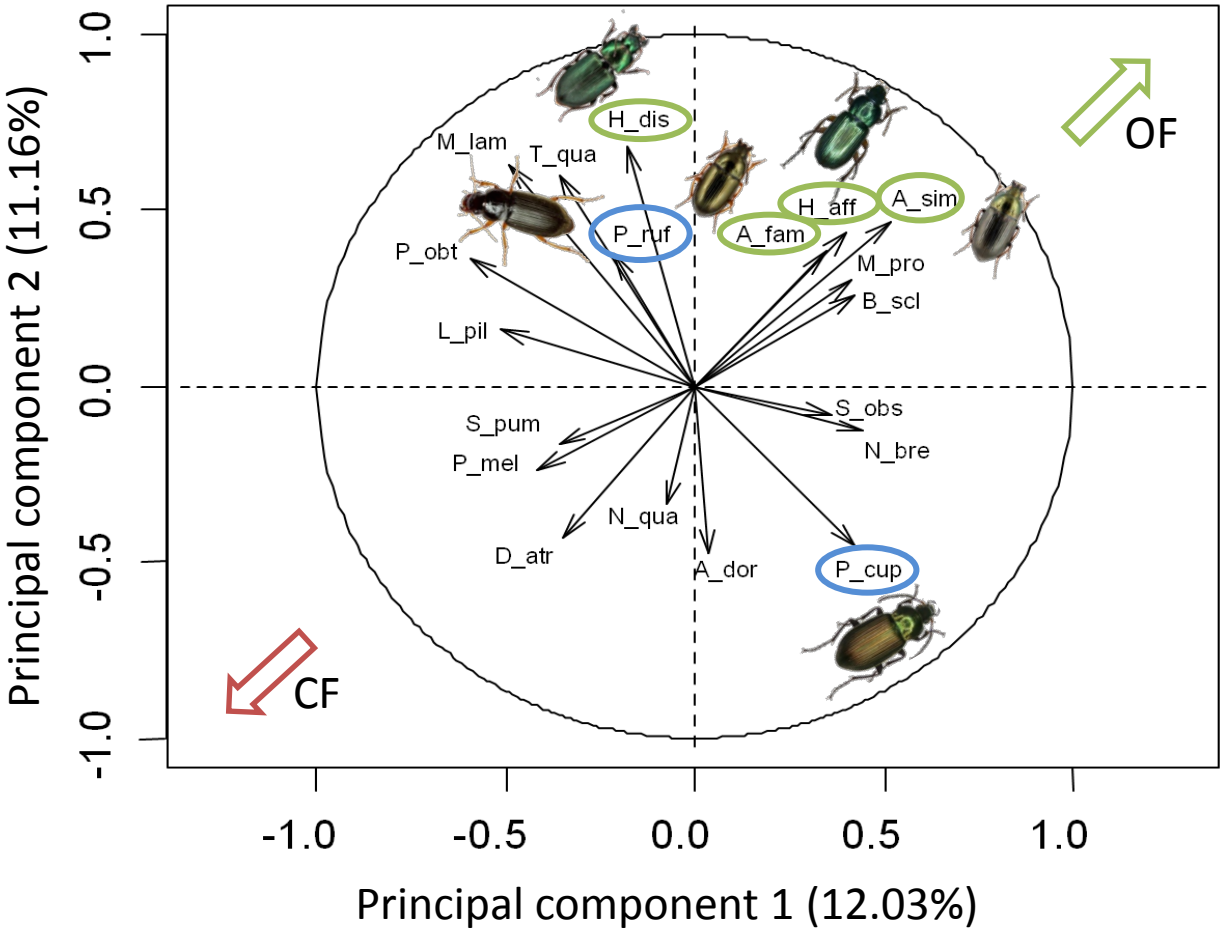

Organic farming :

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  ↳ phytophagous

Results : Local scale

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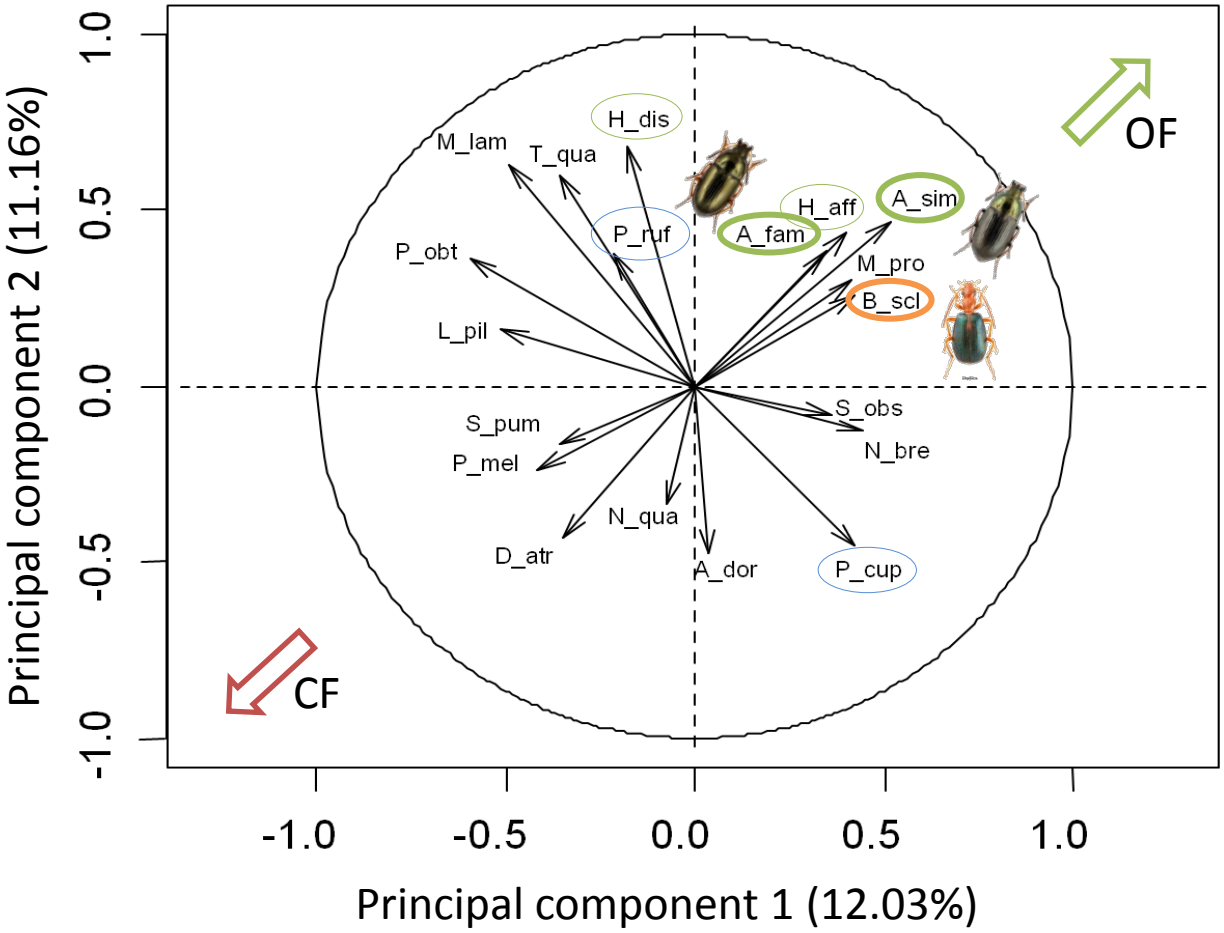

Organic farming :

- Rich vegetation cover
  - ↳ phytophagous
- Genus *Amara*
  - ↳ genus *Brachinus*

Results : Local scale

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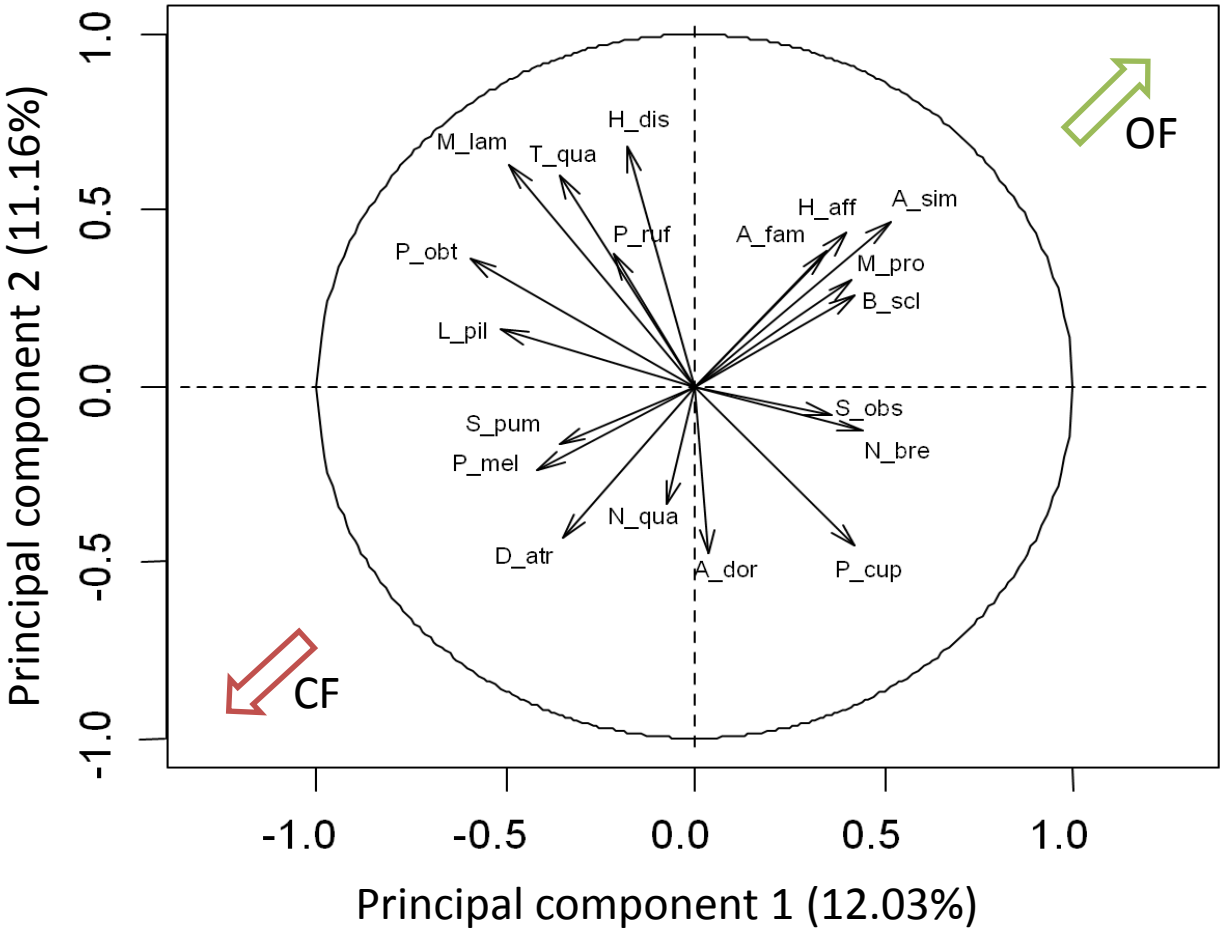

Conventional farming :

- less diverse resources

Results : Local scale

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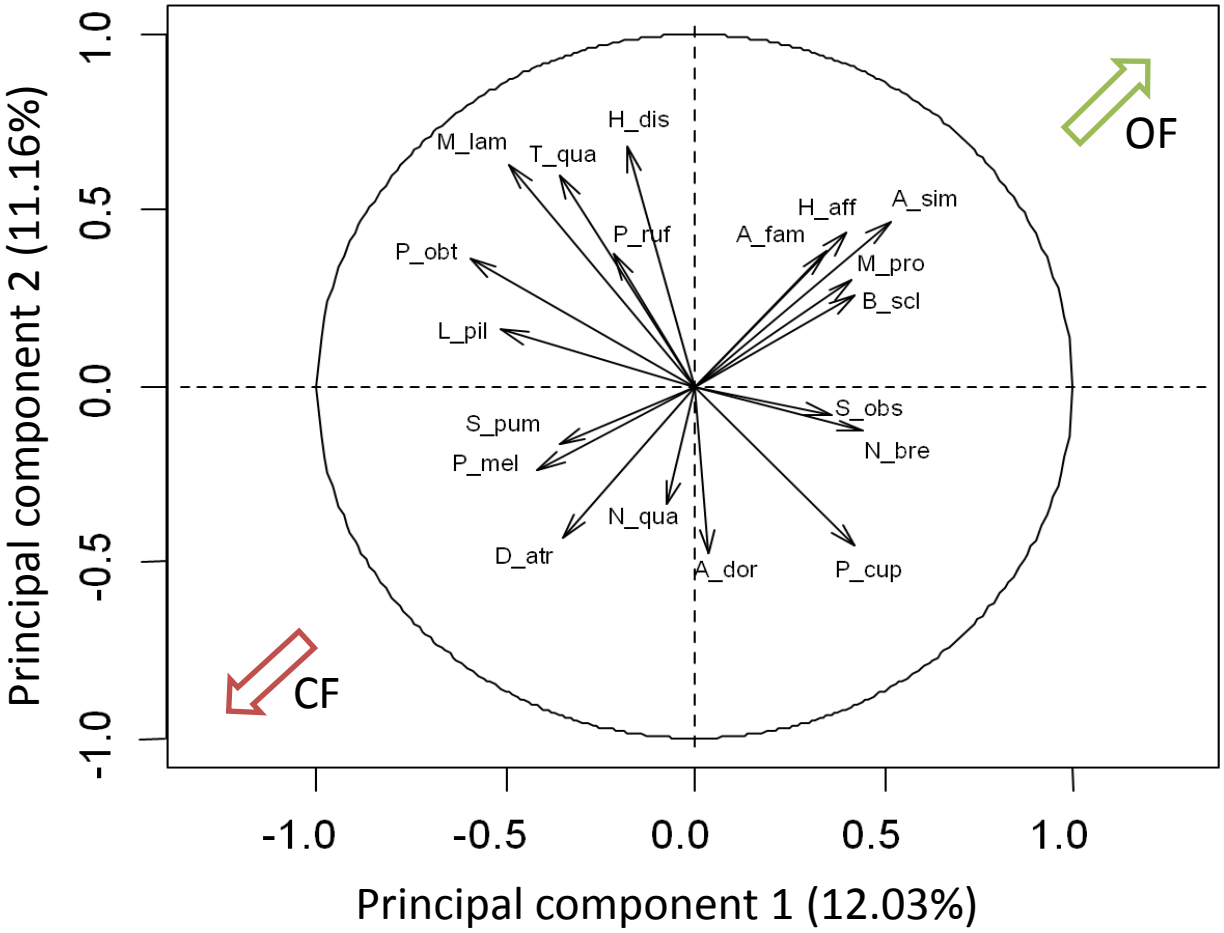

Conventional farming :

- less diverse resources
  - ↳ collembola
  - ↳ slugs
  - ↳ aphids

Results : Local scale

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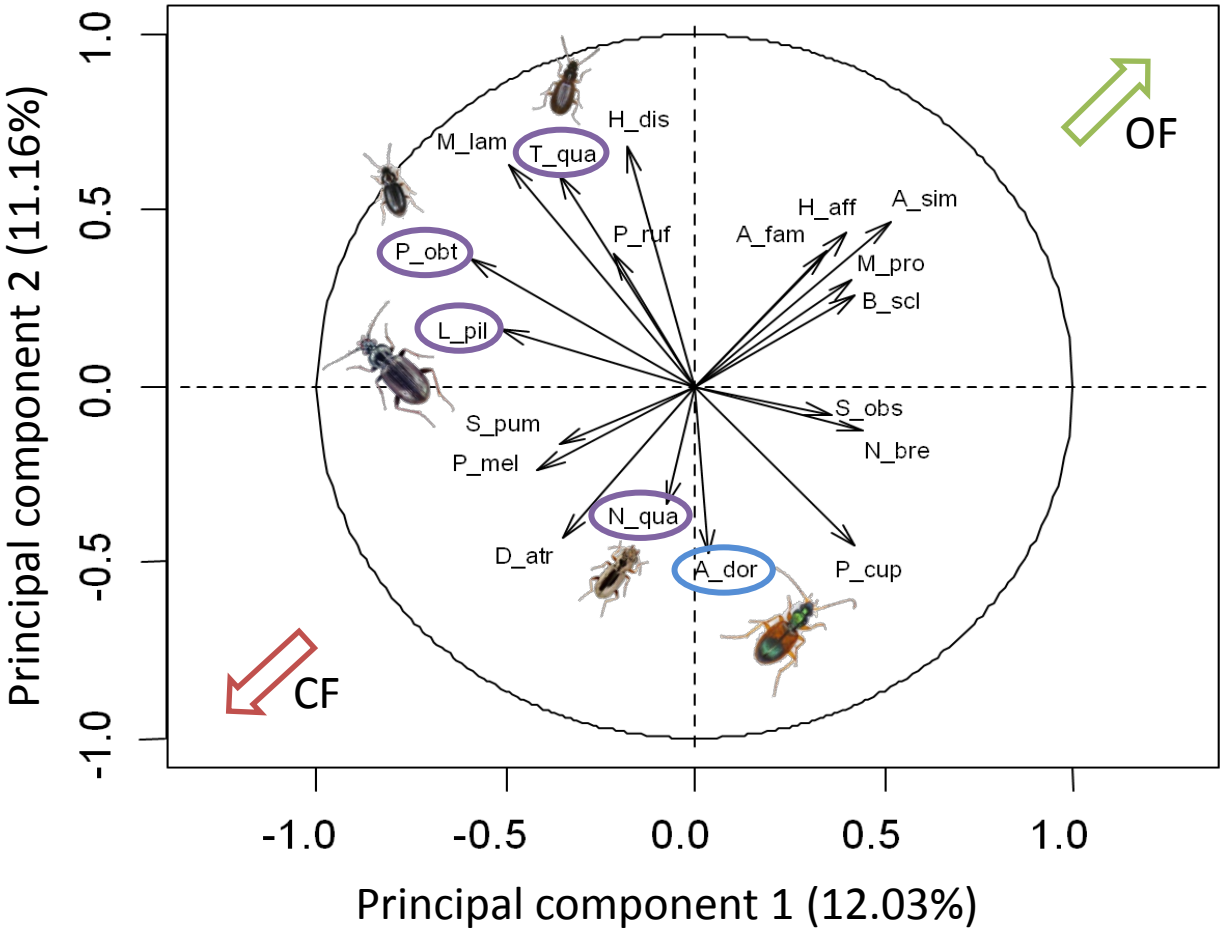

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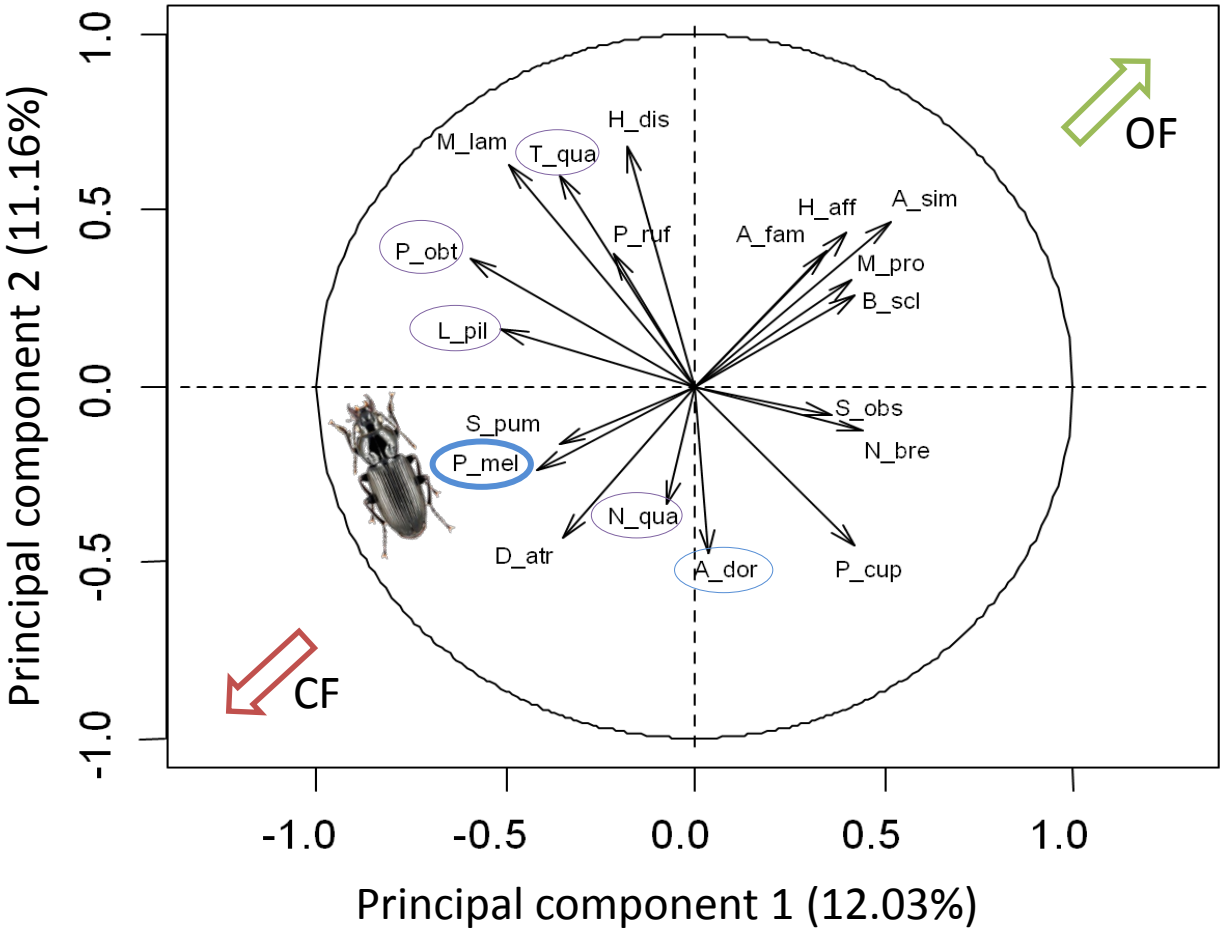

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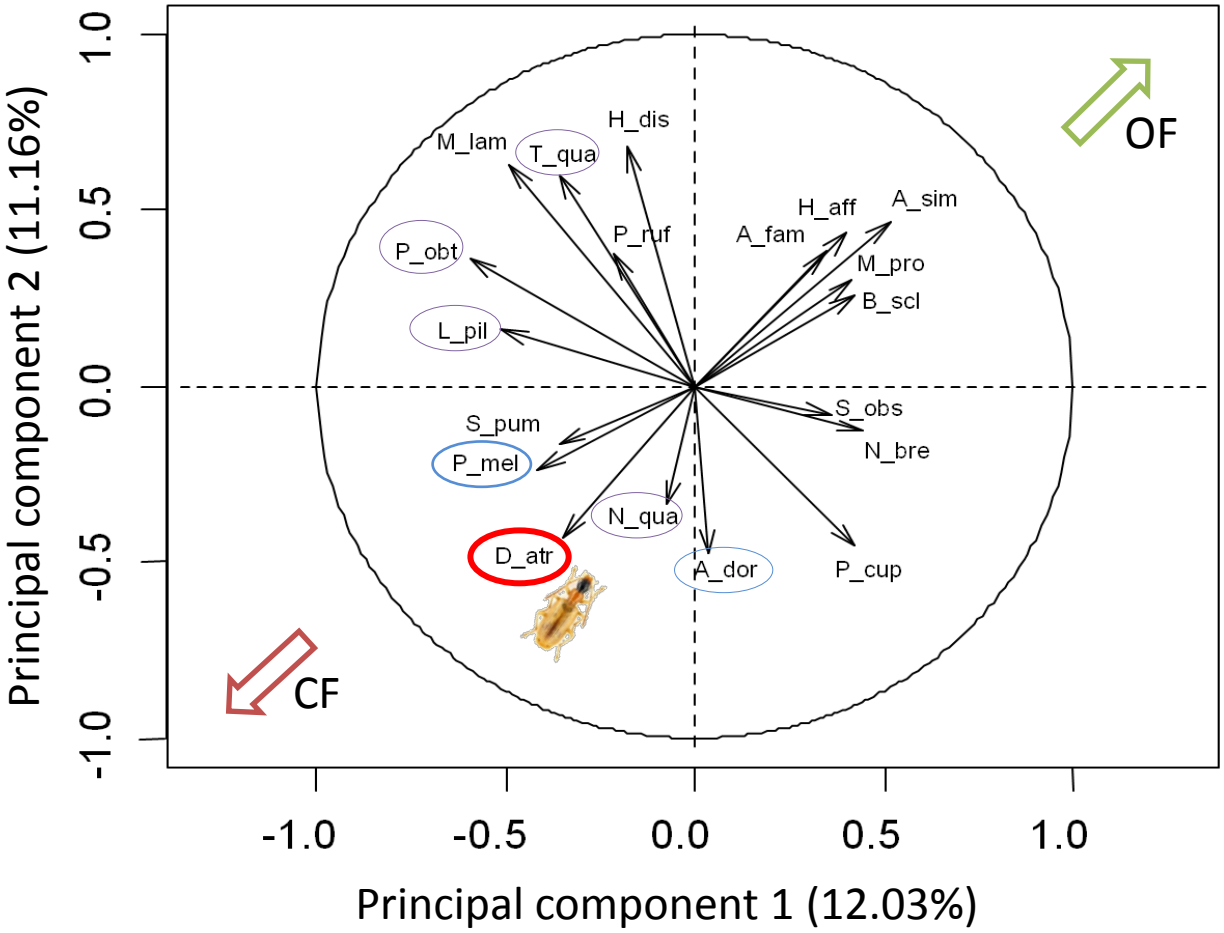

Conventional farming :

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  - ↳ collembola
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  - ↳ **aphids**

Landscape scale

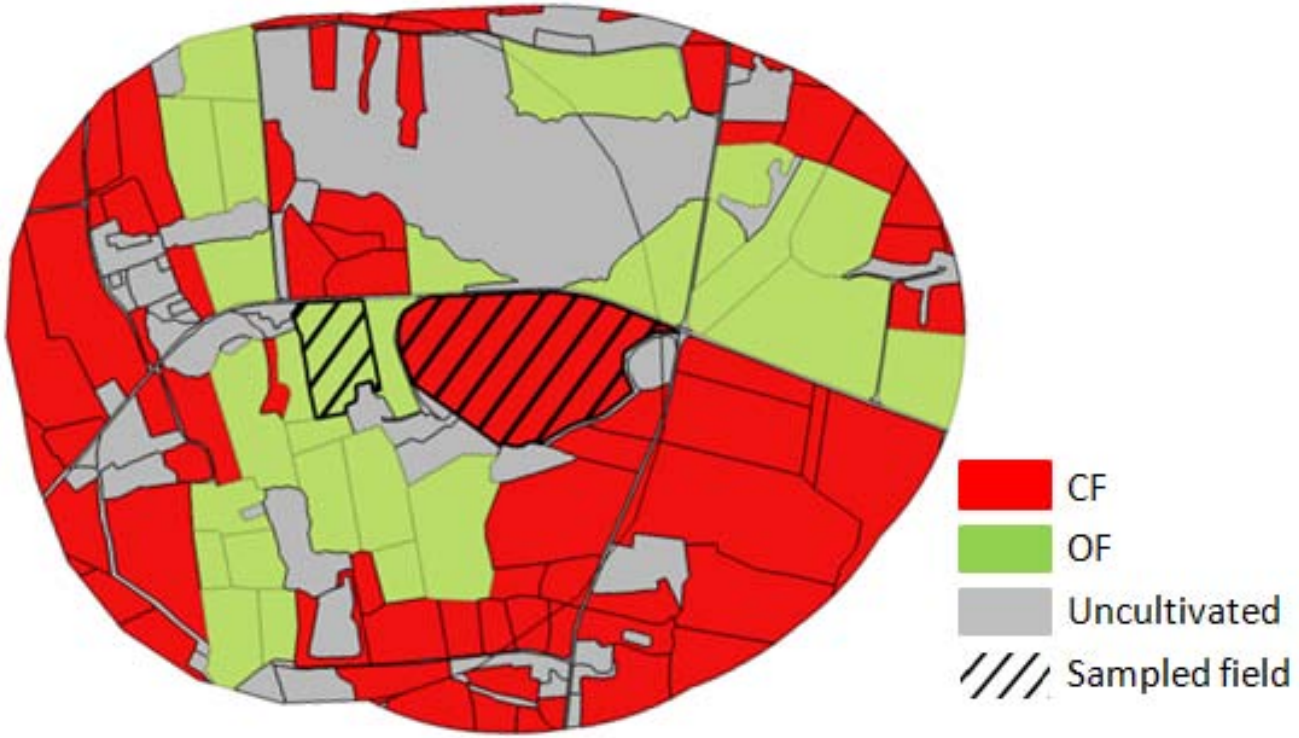
❖ Method

Cartography :

→ Buffer of 500m around fields

→ Information on crops management

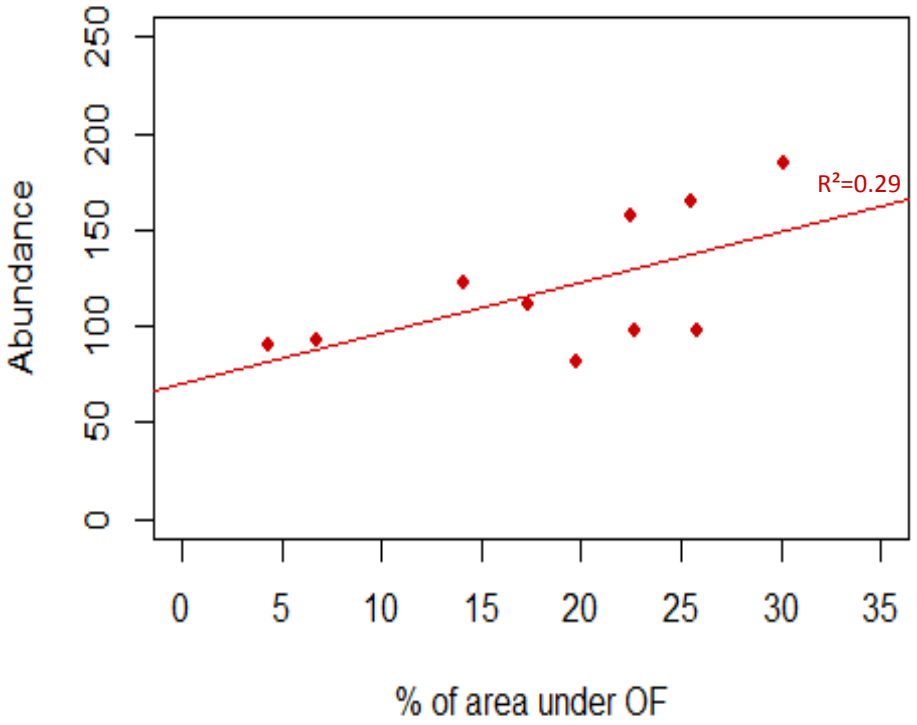
↳ OF gradient in the surroundings of sampling fields.



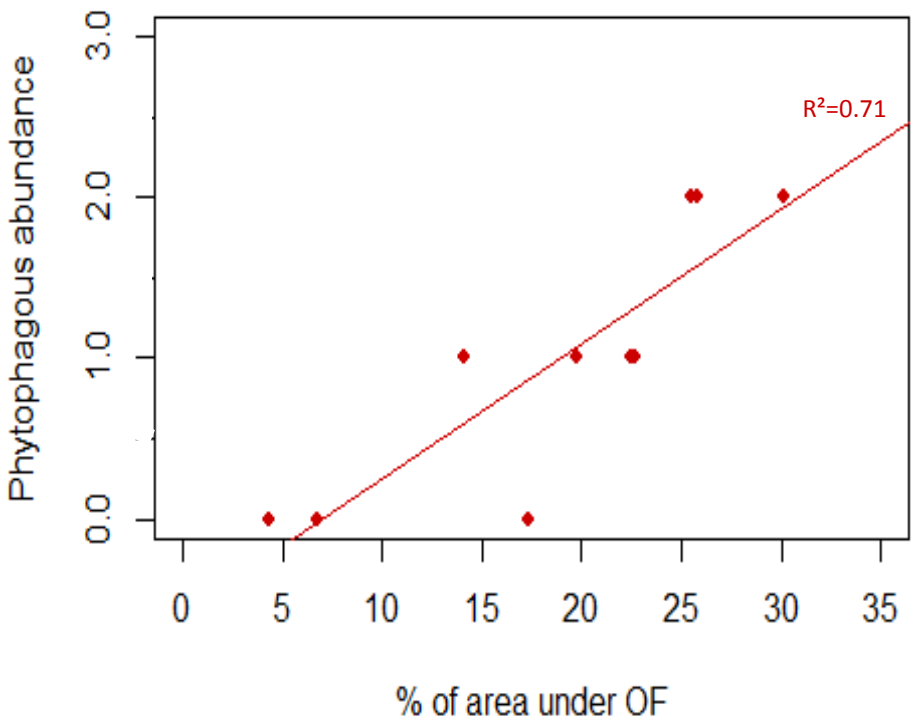
Results : Landscape scale

❖ Influence of OF percentage in the landscape

Total abundances in CF fields



Abundances of phytophagous species in CF fields



Increasing the percentage of organic farming in the landscape :

- ↗ abundance of circulating communities in CF
- ↗ abundance of circulating phytophagous species in CF

Conclusions

- Differences in species composition :
  - OF : phytophagous species
  - CF : collembola eaters

  ↳ Communities structure driven by **resources availability**.

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Organic farming

Conventional farming

- Abundances in circulating communities > in OF.
- Slight differences in abundances in emerging communities.
- Differences between circulating & emerging communities in OF.

  ↳ OF acts as a **sink** → attractiveness of crops

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Organic farming

Conventional farming

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  ↳ Communities structure driven by **resources availability**.

- Abundances in circulating communities > in OF.
- Slight differences in abundances in emerging communities.
- Differences between circulating & emerging communities in OF.

  ↳ OF acts as a **sink** → attractiveness of crops

- Abundances increase in circulating communities in CF in relation with the augmentation of OF percentage in the landscape.

  ↳ OF acts as a **source** → dispersion/dynamics at landscape scale

To go further ...

Interactions between systems

To go further ...

Interactions between systems

Isotopic tool → identifying and quantifying migrant flows

To go further ...

Interactions between systems

⬇

Isotopic tool → identifying and quantifying migrant flows

- Changes in soil~~'s~~ isotopic labelling :
  - → differences in fertilization methods
  - → differences in organic matter origin

To go further ...

Interactions between systems

⬇

Isotopic tool → identifying and quantifying migrant flows

- Changes in soil~~'s~~ isotopic labelling :
  - → differences in fertilization methods
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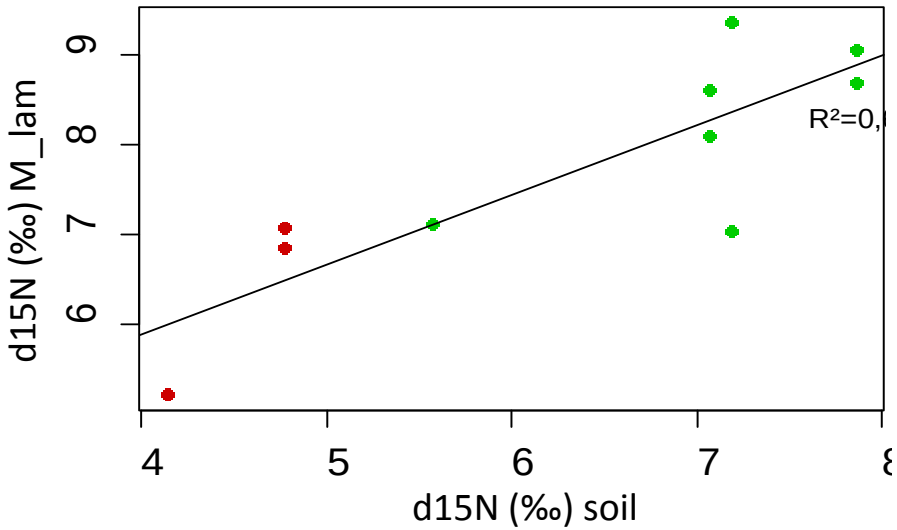
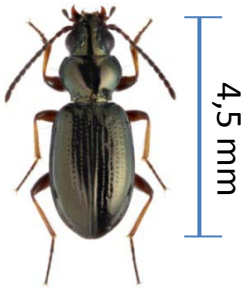
- Isotopic labelling transmission from soils to ground beetle ?

First results : Isotopic labelling

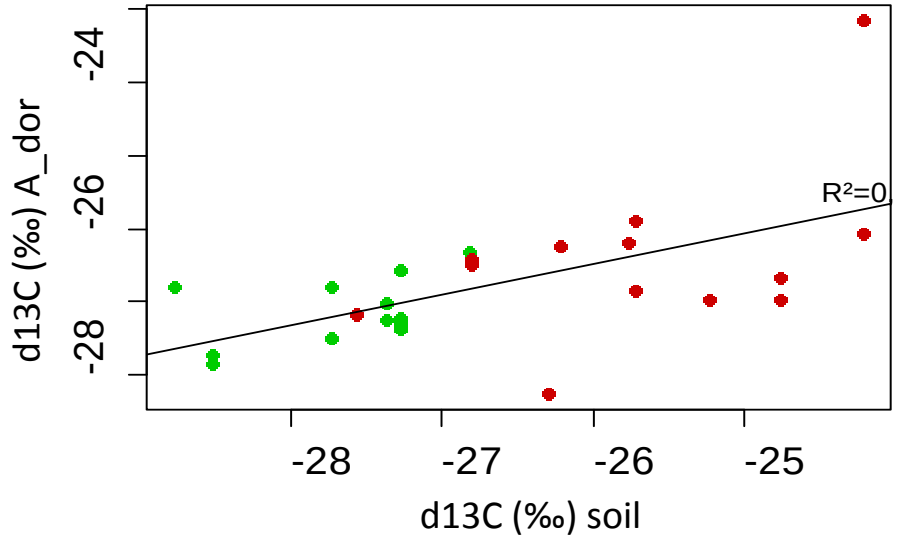
- Isotopic labelling of emerging individuals

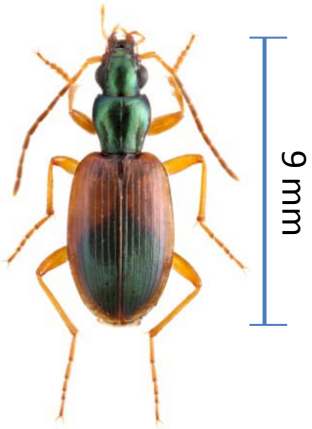
Metallina lampros pros





Anchomenus dorsalis alis





Isotopic labelling

❖ First conclusions

- Coherence soil / ground beetle isotopic labelling

  ↳ confirms usefulness of the method

- High intras~~c~~pecific variability → no individual assignment

Isotopic labelling

❖ First conclusions

- Coherence soil / ground beetle isotopic labelling
  - ↳ confirms usefulness of the method
- High intraspecific variability → no individual assignment
- The method allows the evaluation of the contribution at populational scale.

⬇

importance and **temporality exchanges**
between both farming systems.

Prospects

- **Organic farming** :
  - sink in spring → attractiveness of crops
  - source at farm scale → management and type of marginal areas
  - source at the scale of multiannual dynamics

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  - → temporal variability of habitats

  to **assess** :
  - → relative contribution of farming systems for auxiliary production
  - → exchanges of migrants between farming systems

  and thus **quantify** their influence in terms of biological control.

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  - → exchanges of migrants between farming systems

  and thus **quantify** their influence in terms of biological control.

- Utilization of **isotopic tool** to characterize the **migrant flows** between farming systems.

Thank you for your attention.