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



UMR 1349 INRA-Agrocampus Ouest-Université Rennes, IGEPP

Maud Belhache, El Aziz Djoudi, Stéphanie Aviron,
Julien Pétilion and Manuel Plantegenest

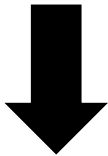
Context

- 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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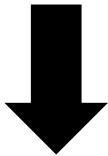


Beneficial effect on the **abundance** and **species richness** of **ground beetle communities**.



Context

- Needs for more **sustainable** and **healthy** agricultural systems
- **Development of Organic farming**
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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



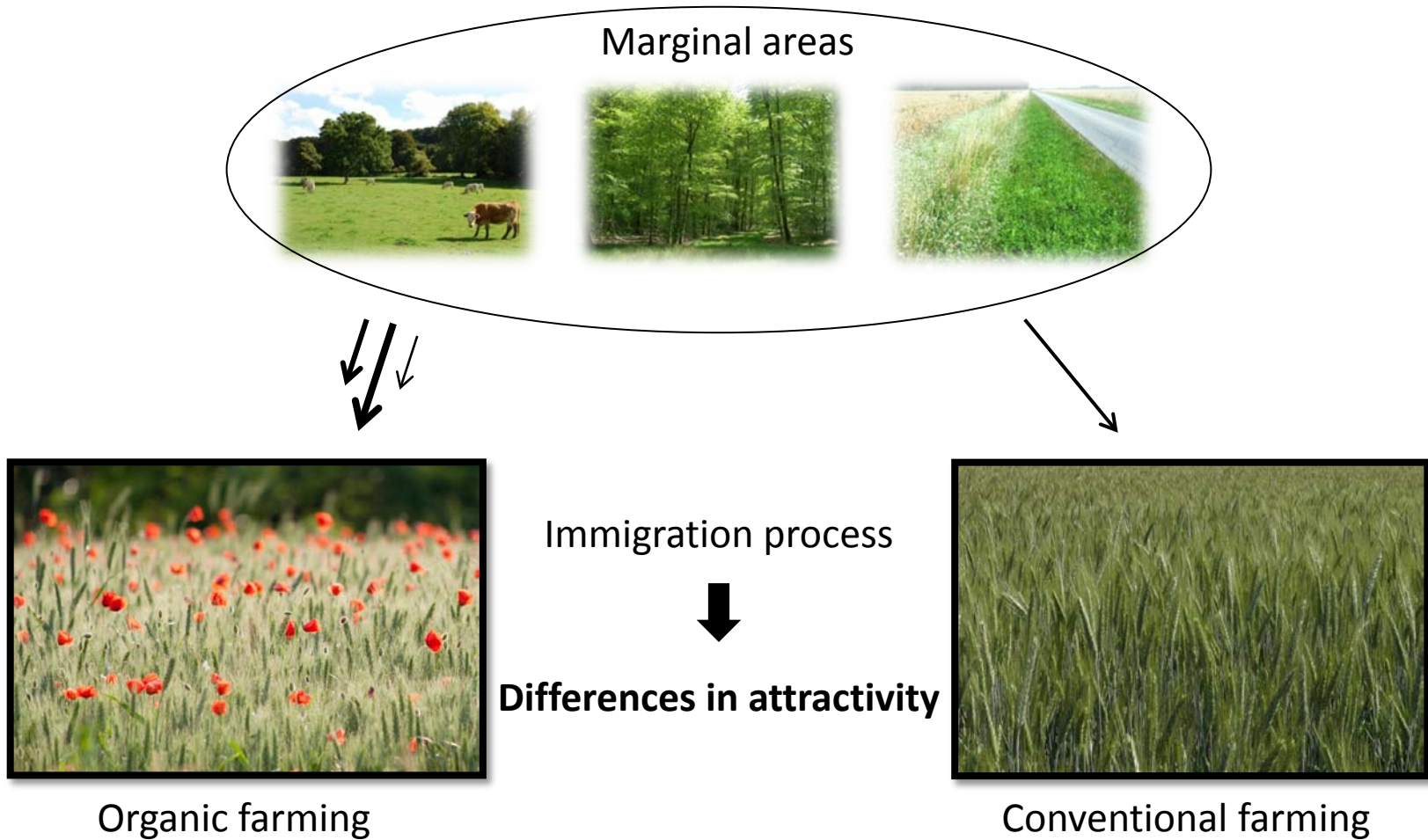
Conventional farming

Differences in species abundances and composition

Context

➤ Differences in abundances and species composition (richness)

↳ **landscape scale processes**



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 ?**



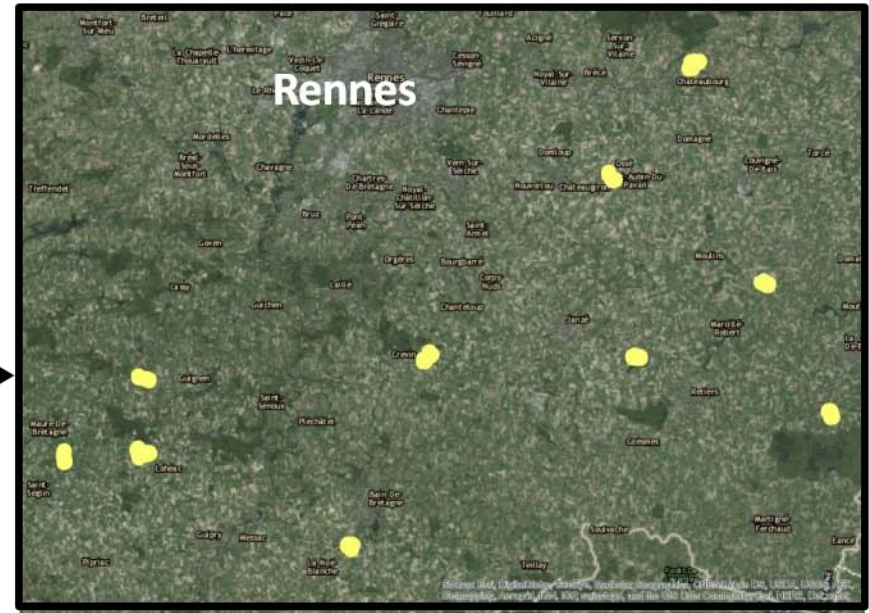
Influence of the proportion of organic farming at landscape scale ?

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

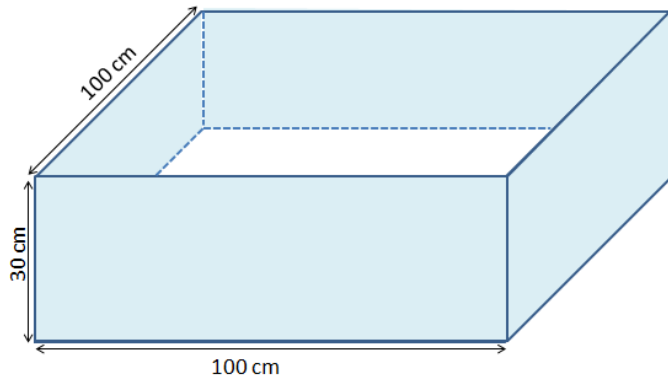


Selection of :

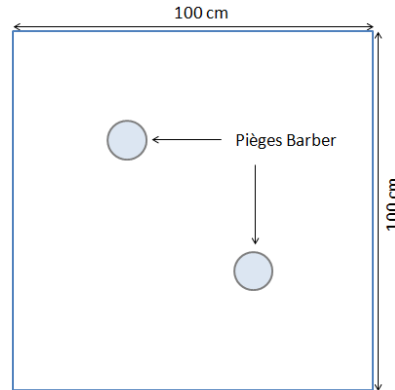
- 10 landscapes in Brittany
 - ↳ 20 wheat fields
 - 10 under organic farming
 - 10 under conventional farming

Method

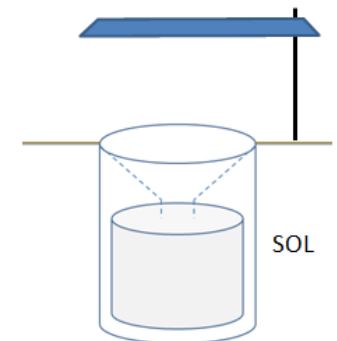
❖ Experimental device



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

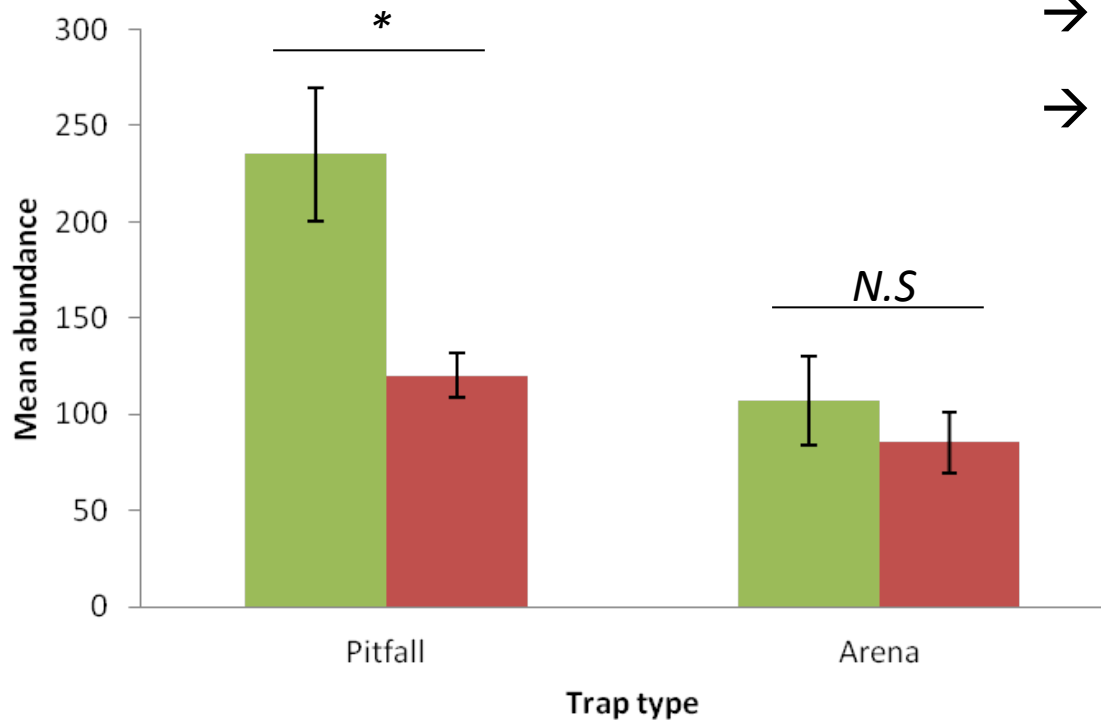
Results : Local scale

❖ Abundances

Higher abundances in OF :

→ attractive effect ?

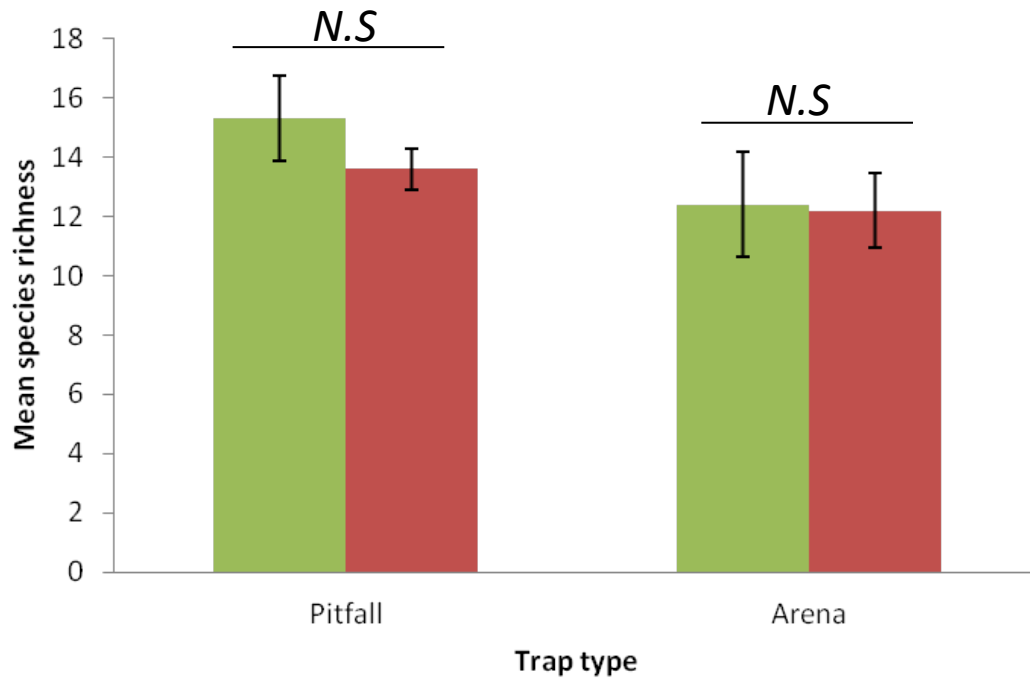
→ differences in mortality rates ?



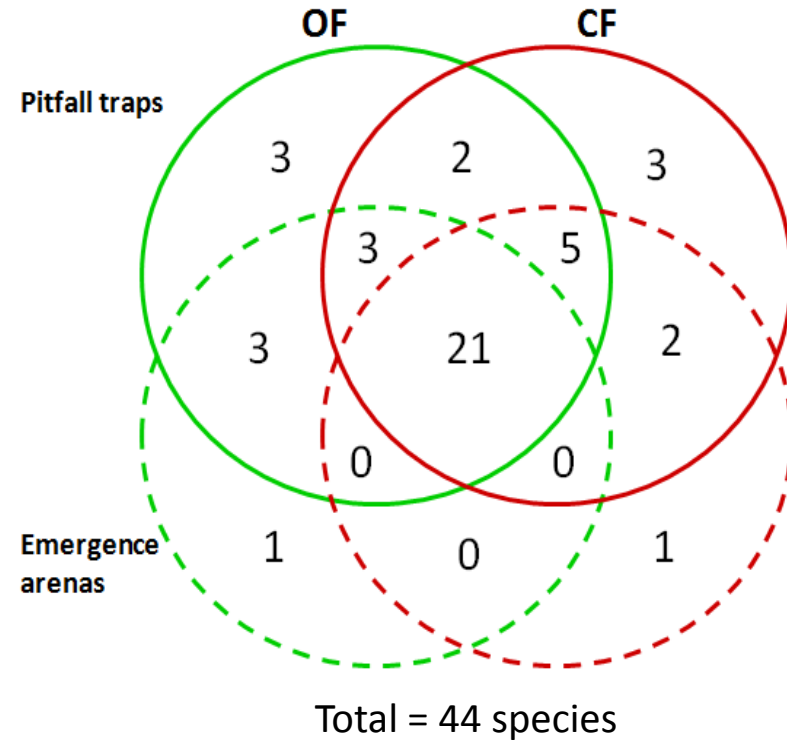
N.S : nonsignificant difference ; * : $P < 0.05$
green : OF and red: CF

Results : Local scale

❖ Species richness



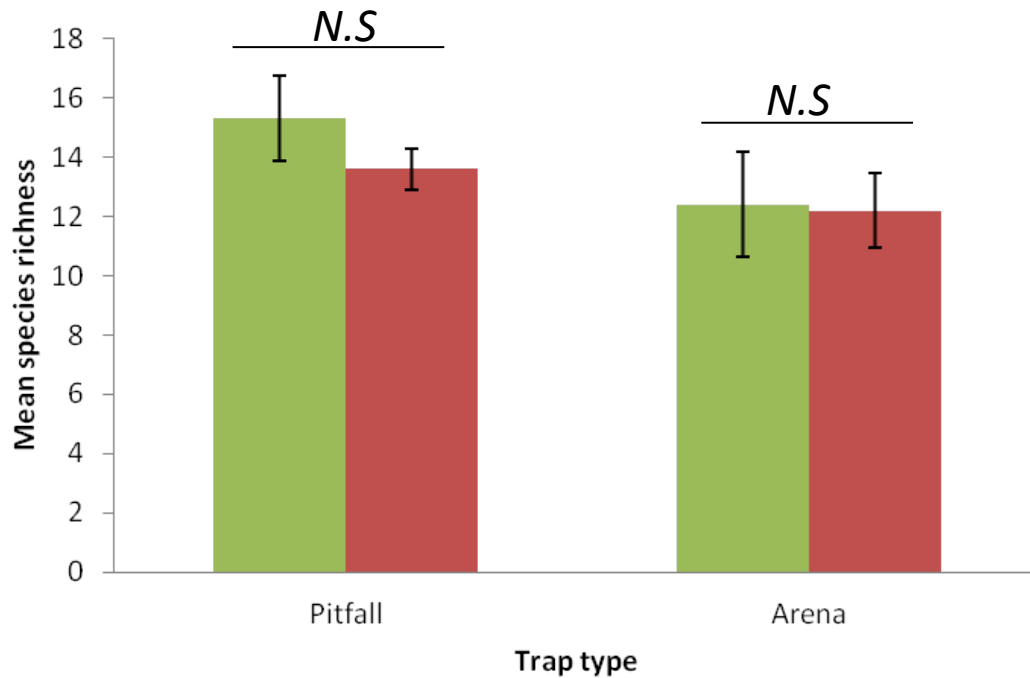
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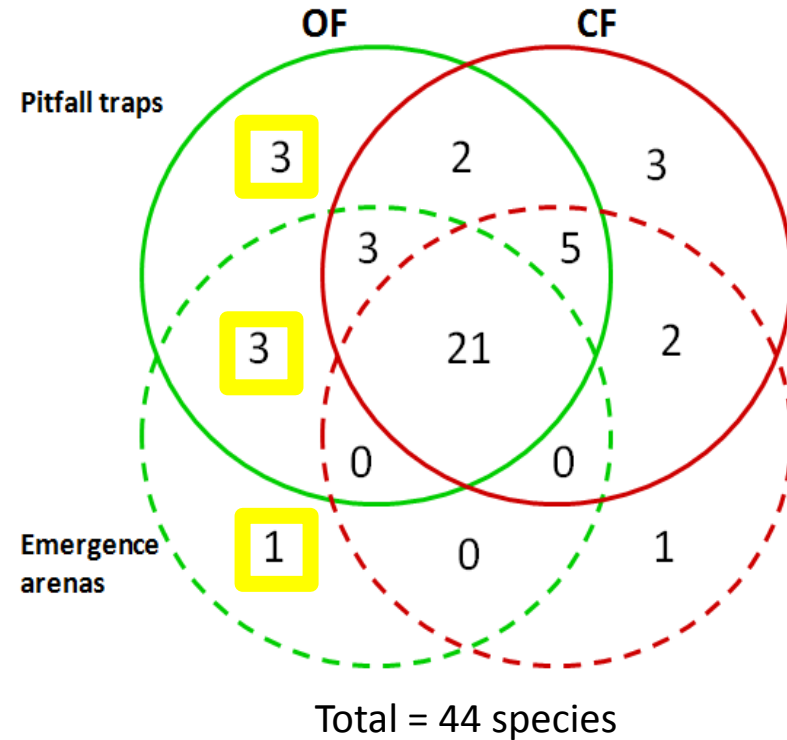
➤ Similar species richness in the two systems.

Results : Local scale

❖ Species richness



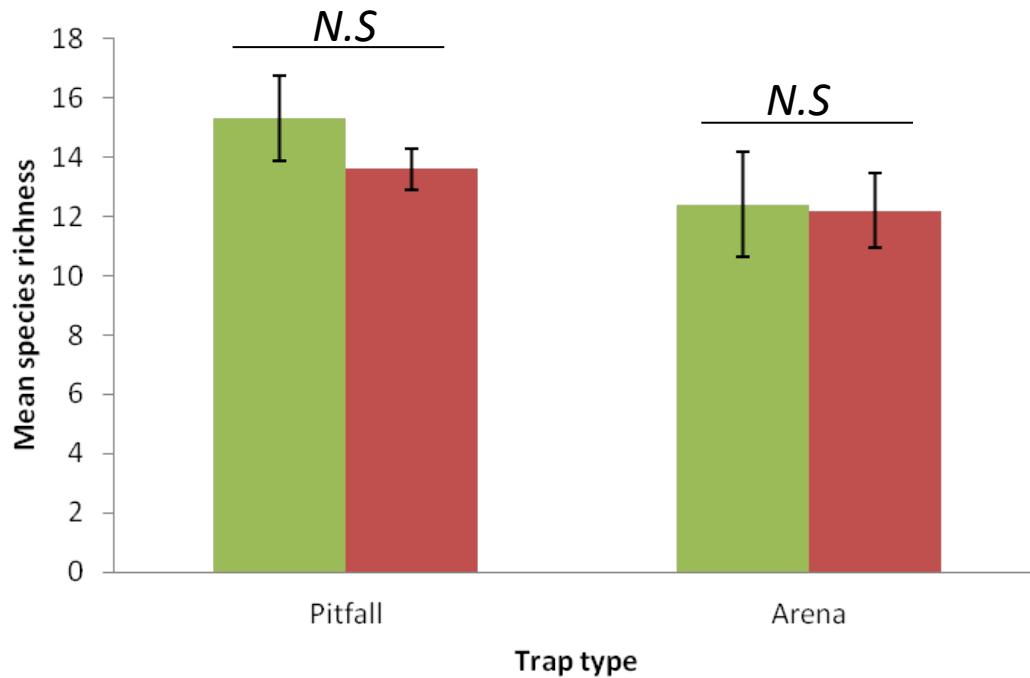
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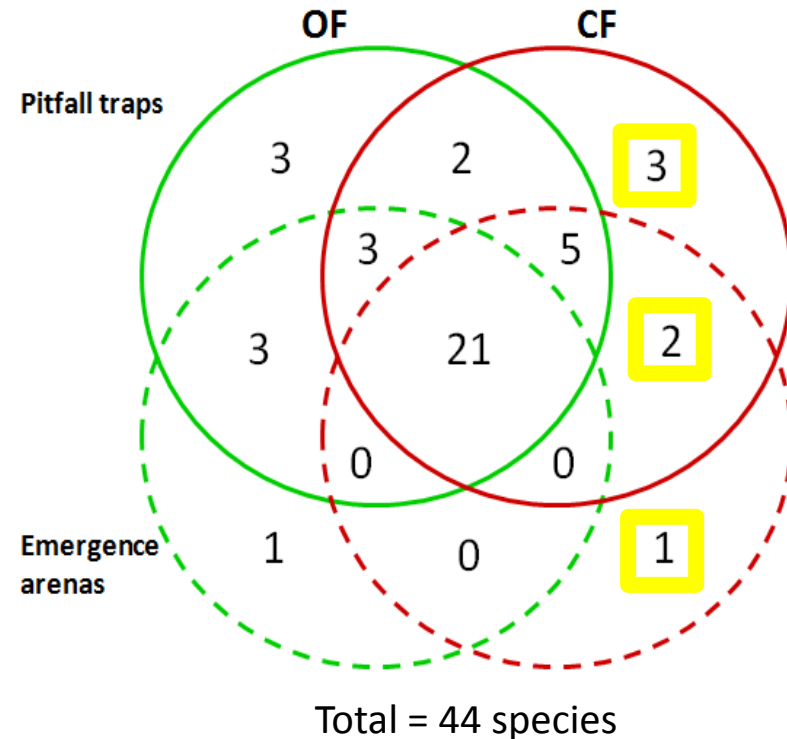
- Similar species richness between the two systems.
- Variation in communities composition.

Results : Local scale

❖ Species richness



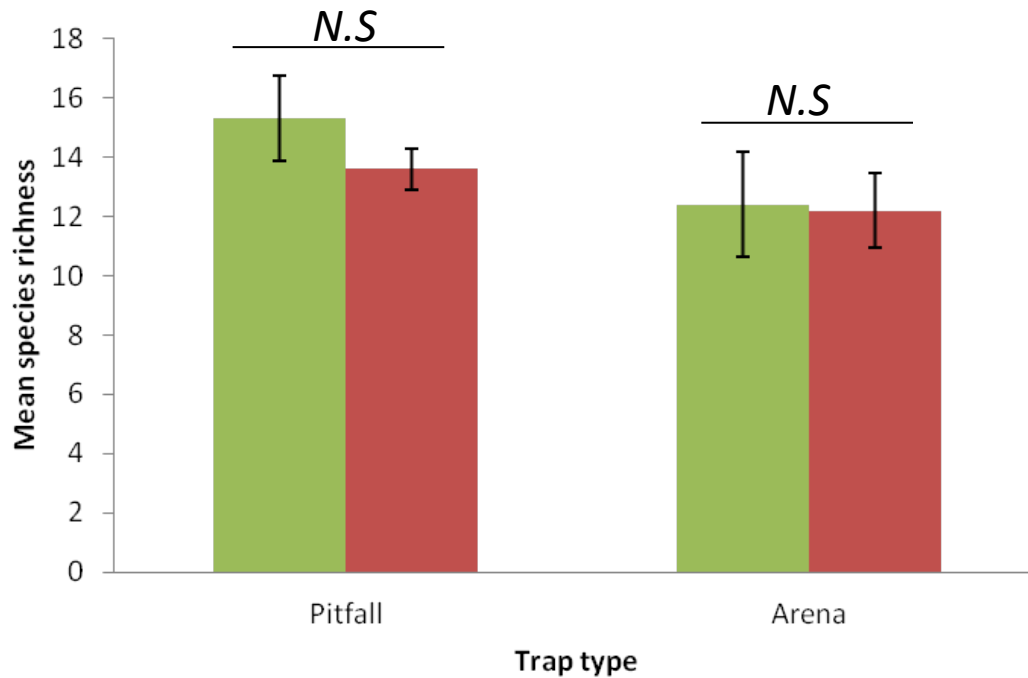
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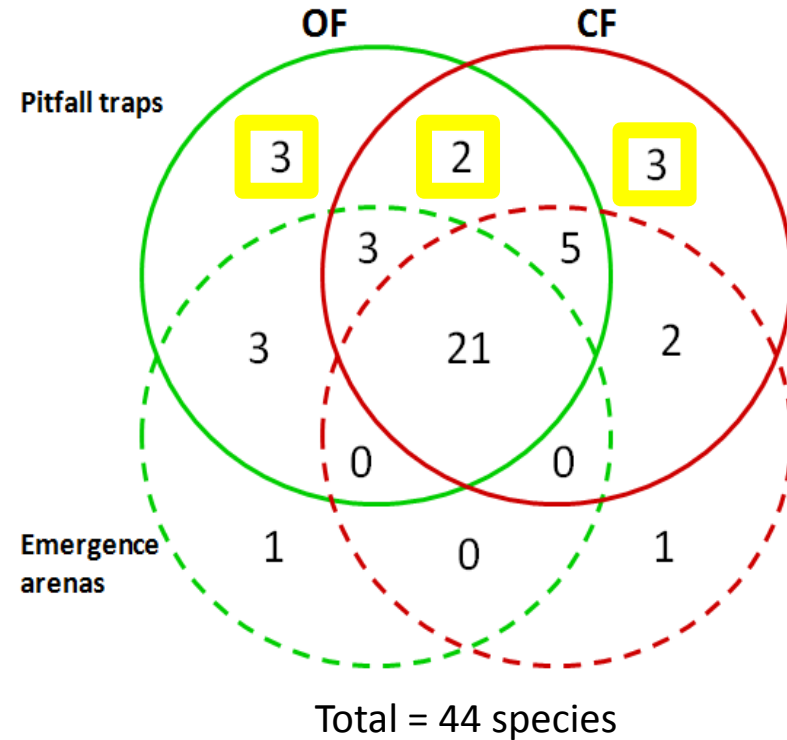
- Similar species richness between the two systems.
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❖ Species richness



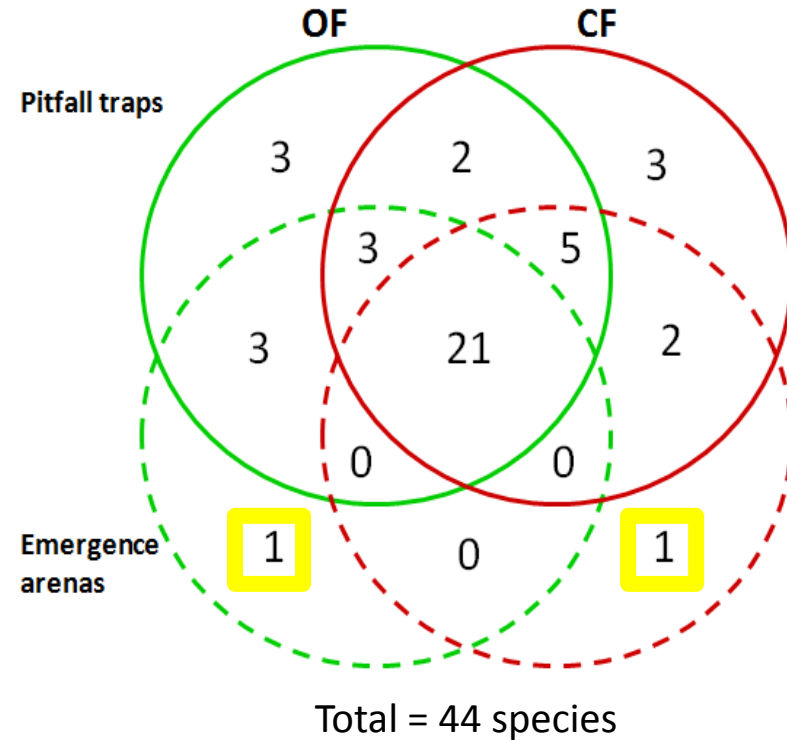
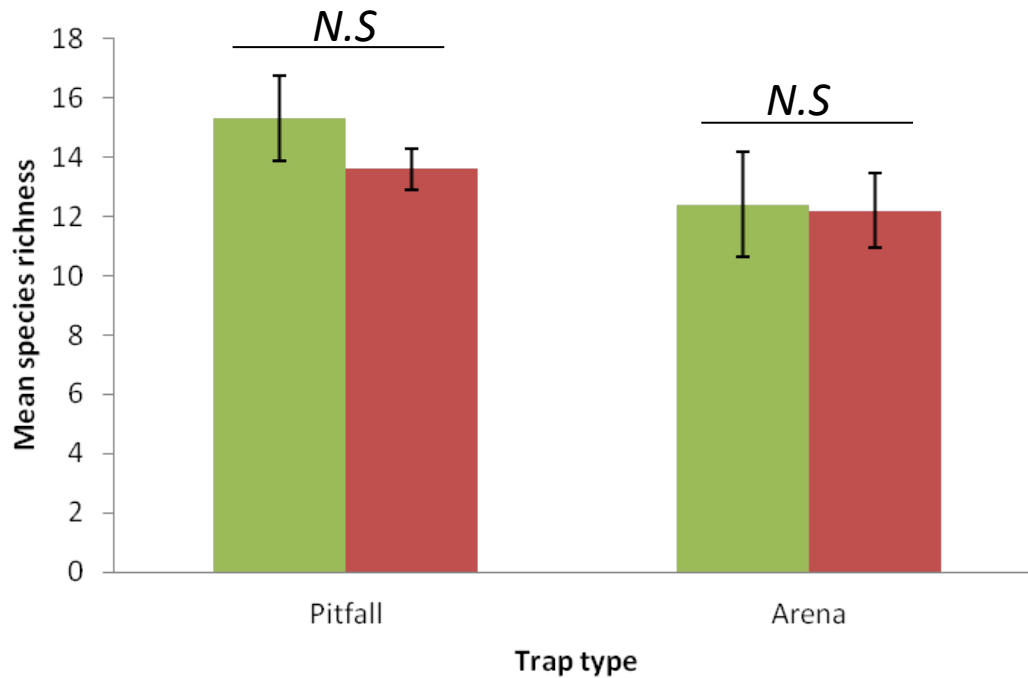
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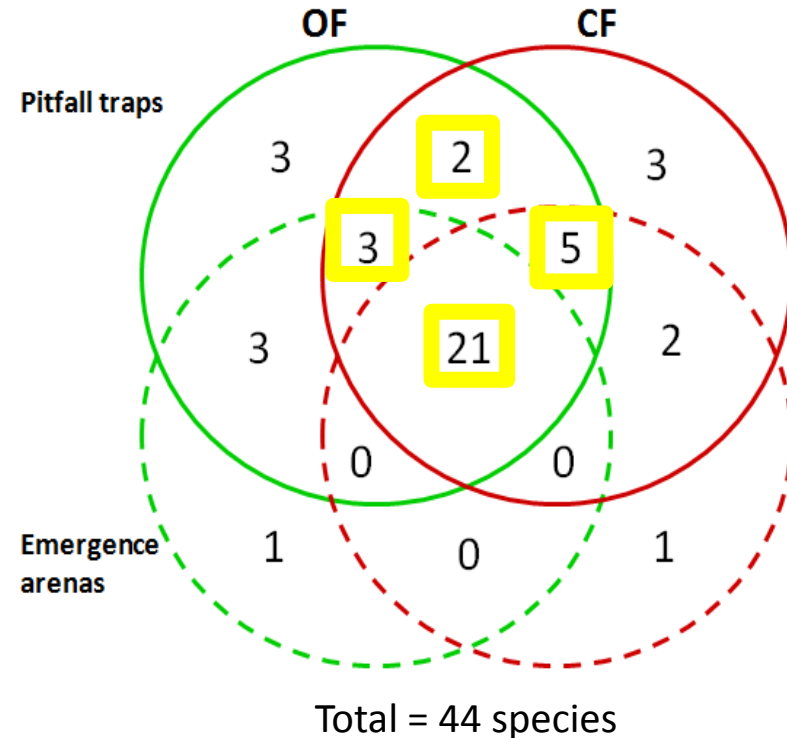
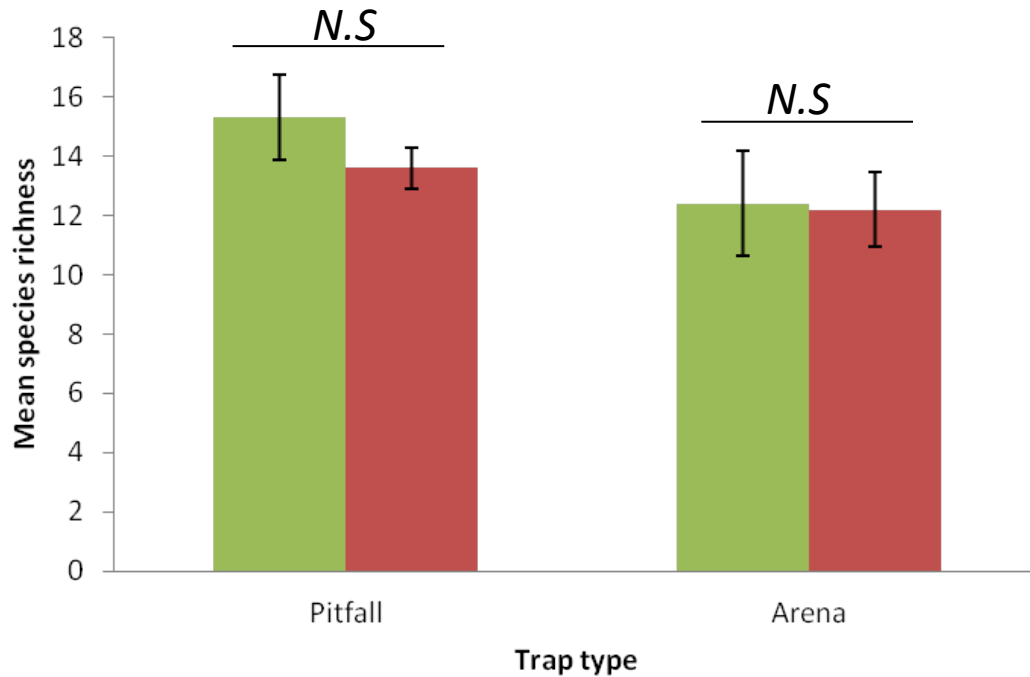
❖ Species richness



- Similar species richness between the two systems.
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Results : Local scale

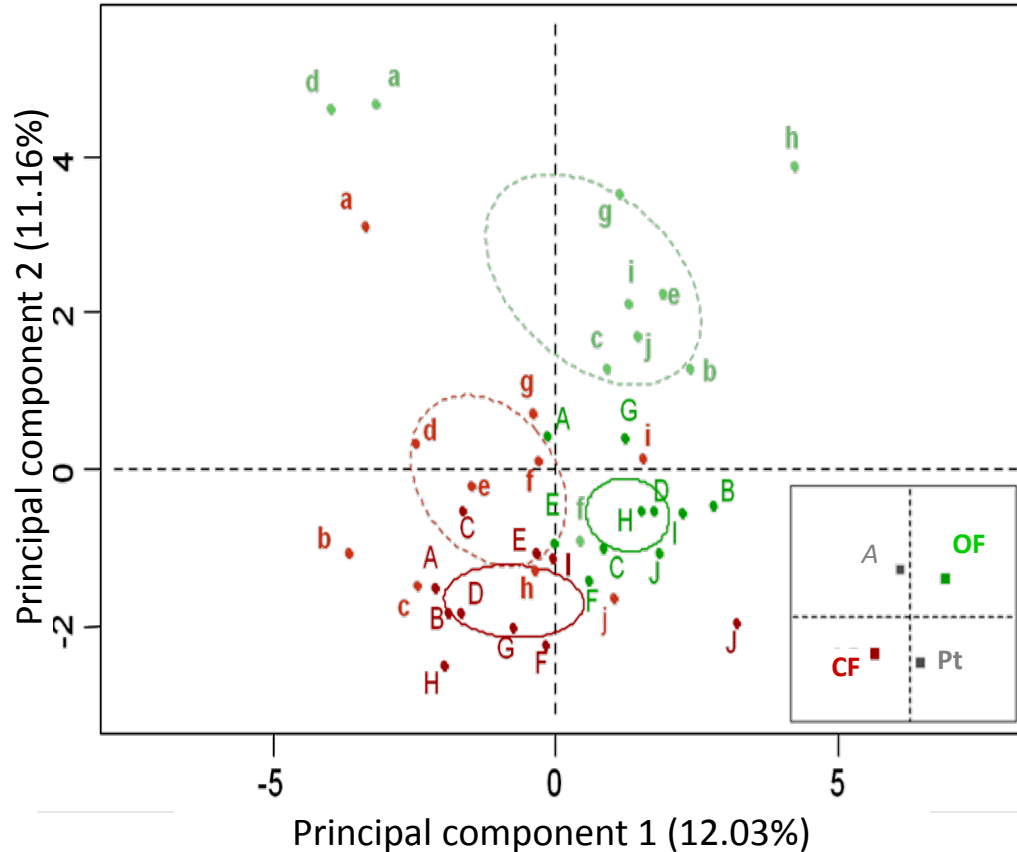
❖ Species richness



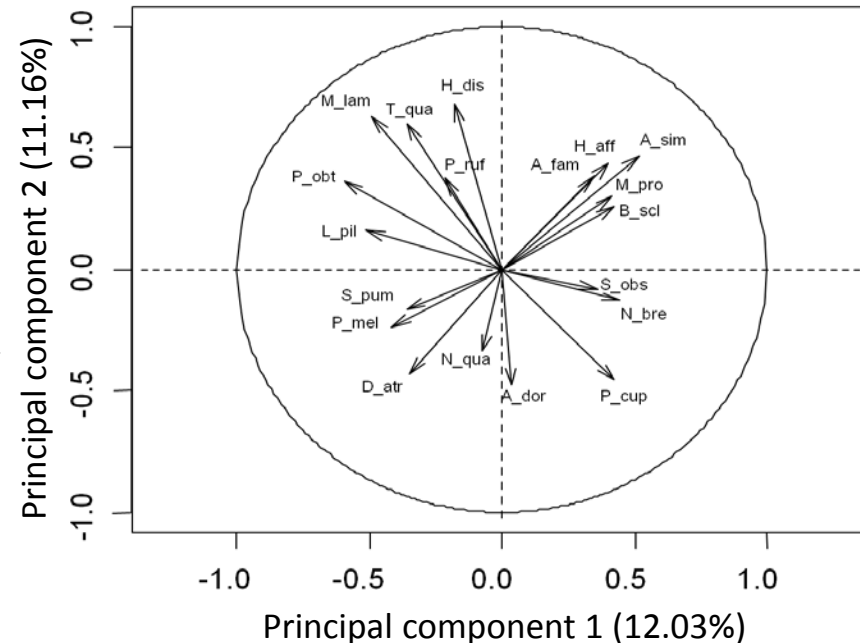
- Similar species richness between the two systems.
- Majority of species are present in the two systems.

Results : Local scale

❖ Specific composition of ground beetle communities

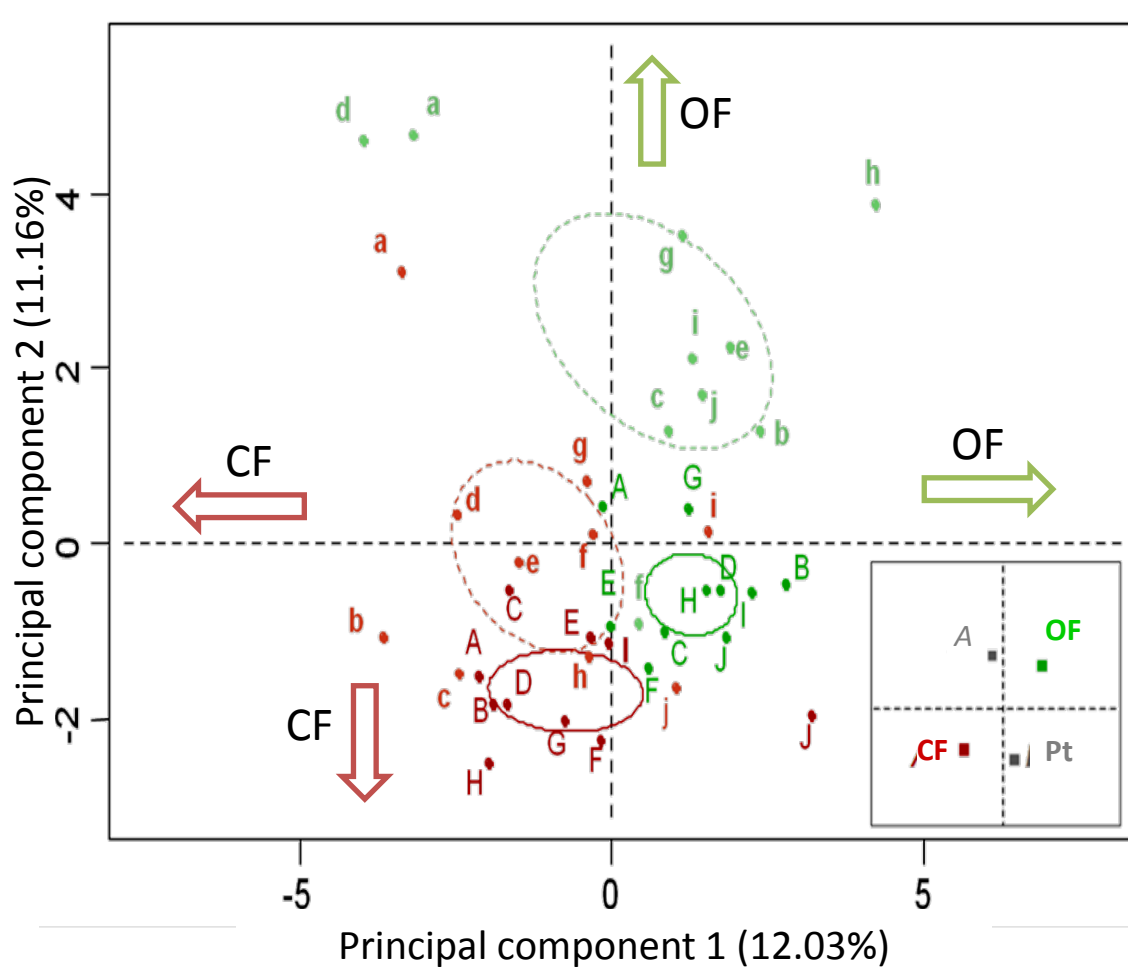


PCA : **species proportions** captured in both trap types during the entire sampling period.



Results : Local scale

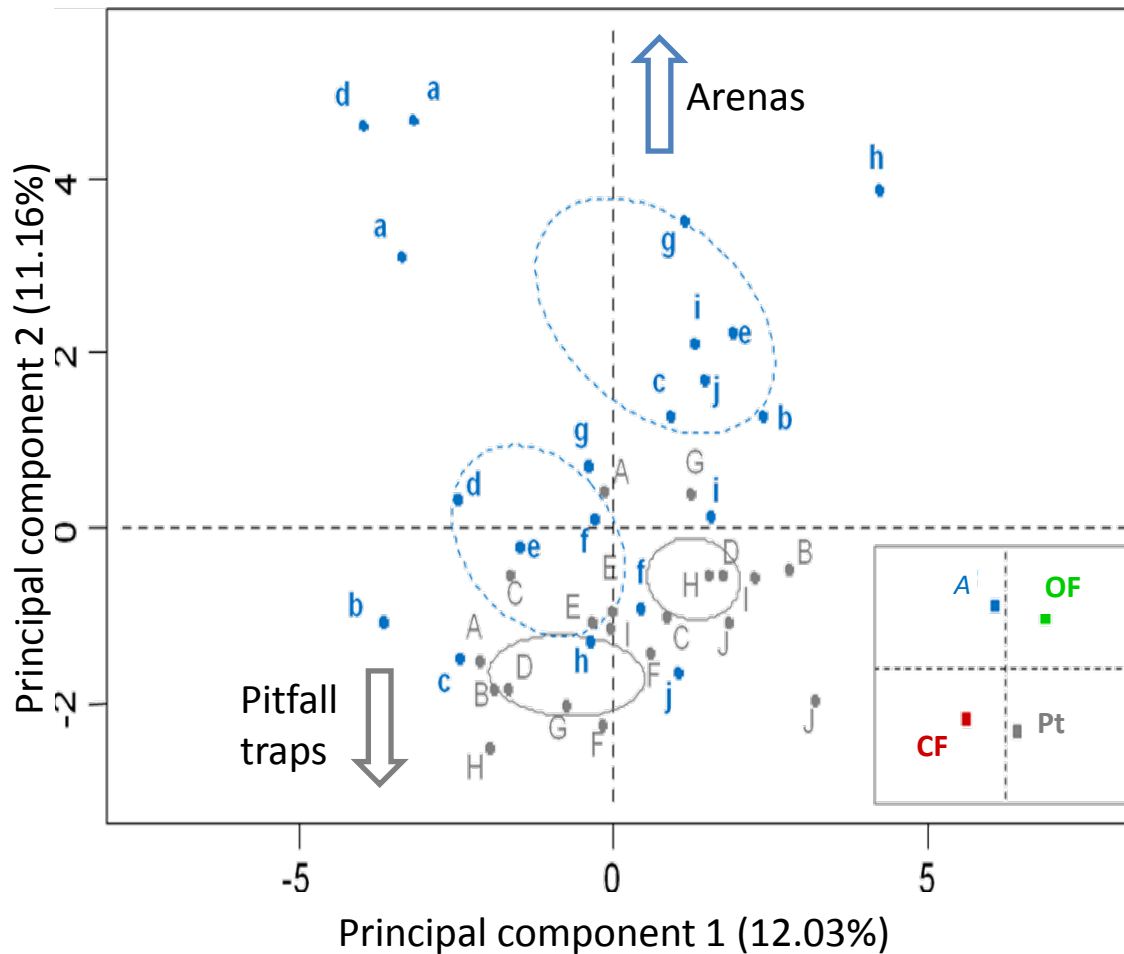
- ❖ Specific composition of ground beetle communities



Axe 1 & 2 :
organic and conventional
communities differ

Results : Local scale

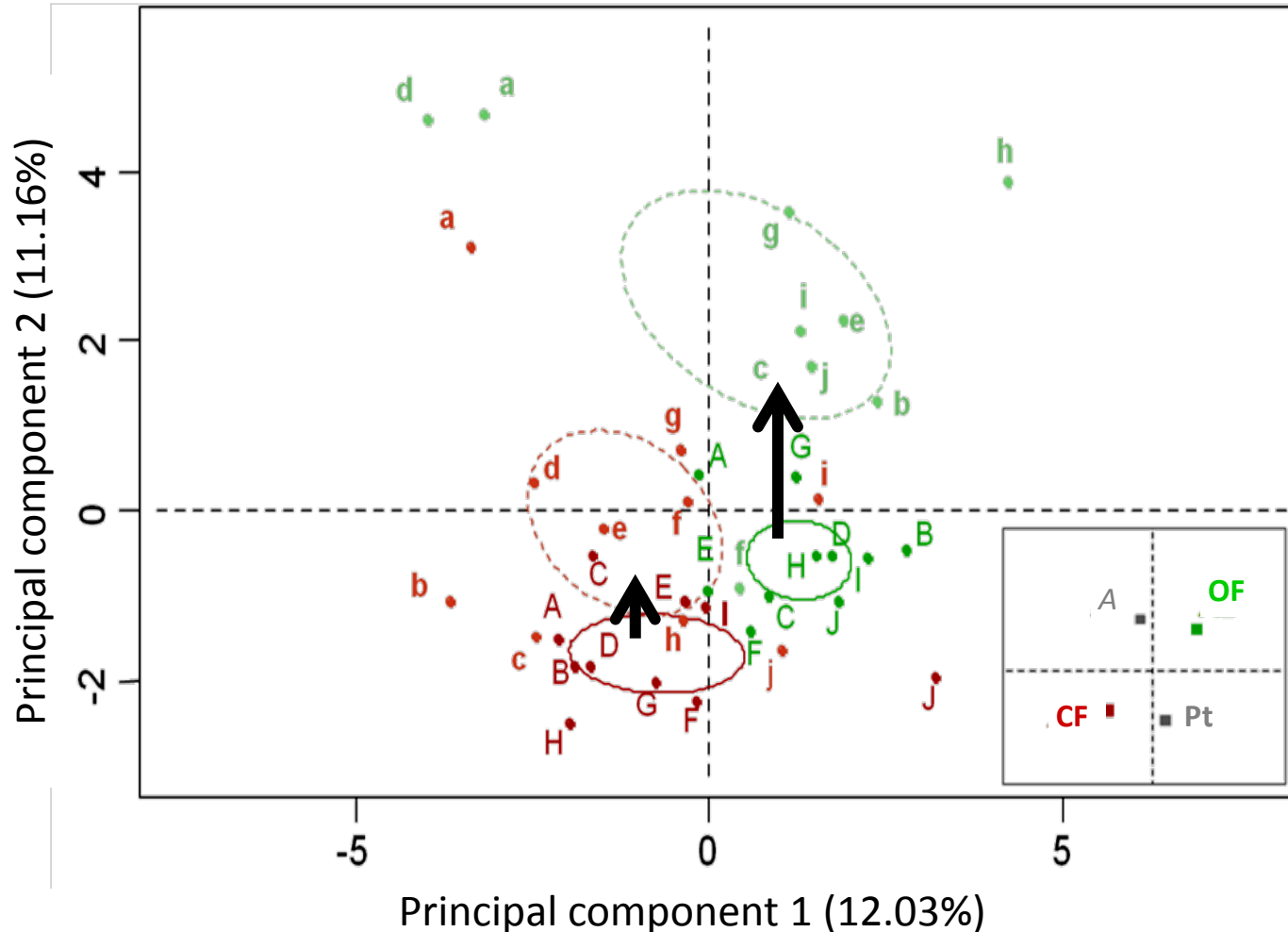
- ❖ Specific composition of ground beetle communities



Axe 2 :
circulating and emerging
communities differ

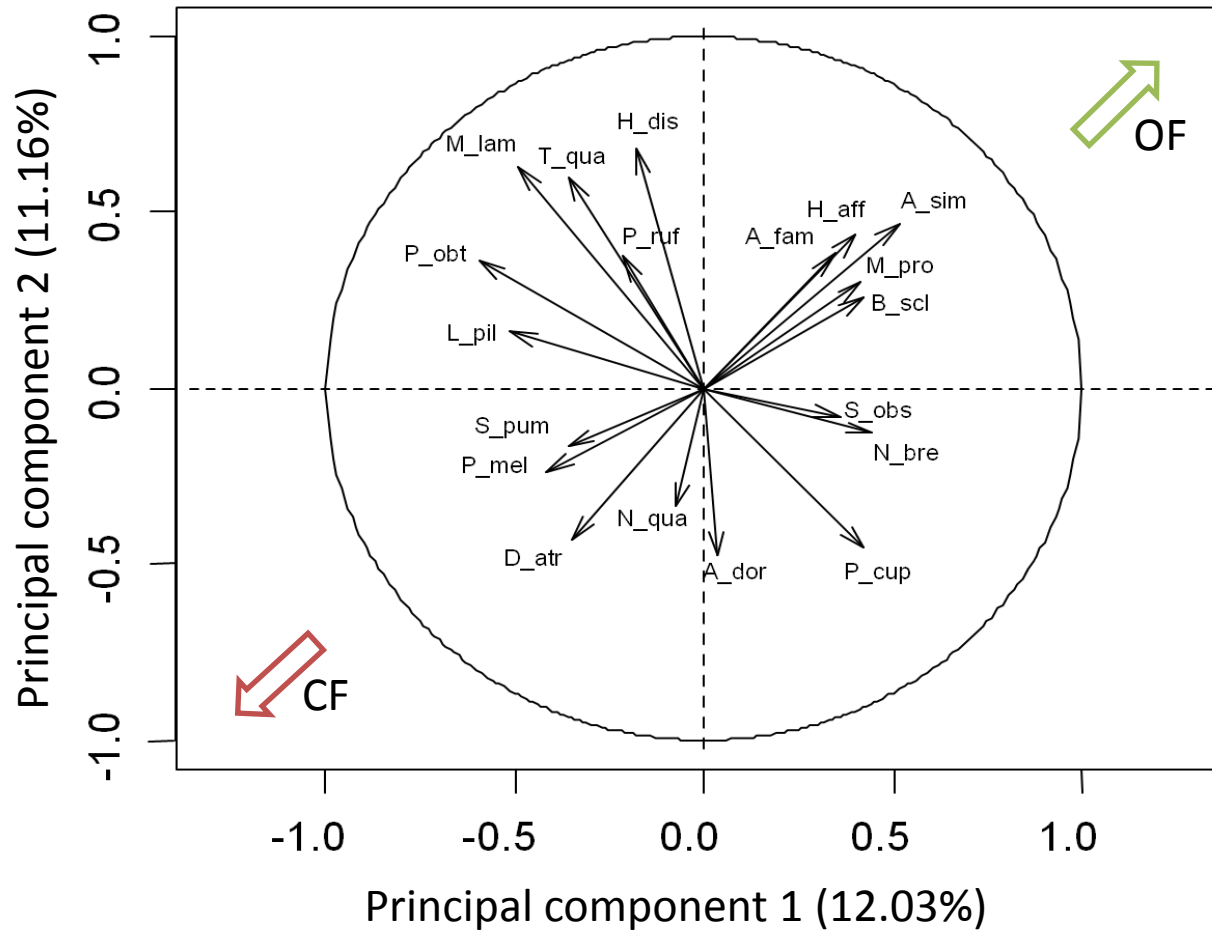
Results : Local scale

- ❖ Specific composition of ground beetle communities



Results : Local scale

❖ Specific composition of ground beetle communities

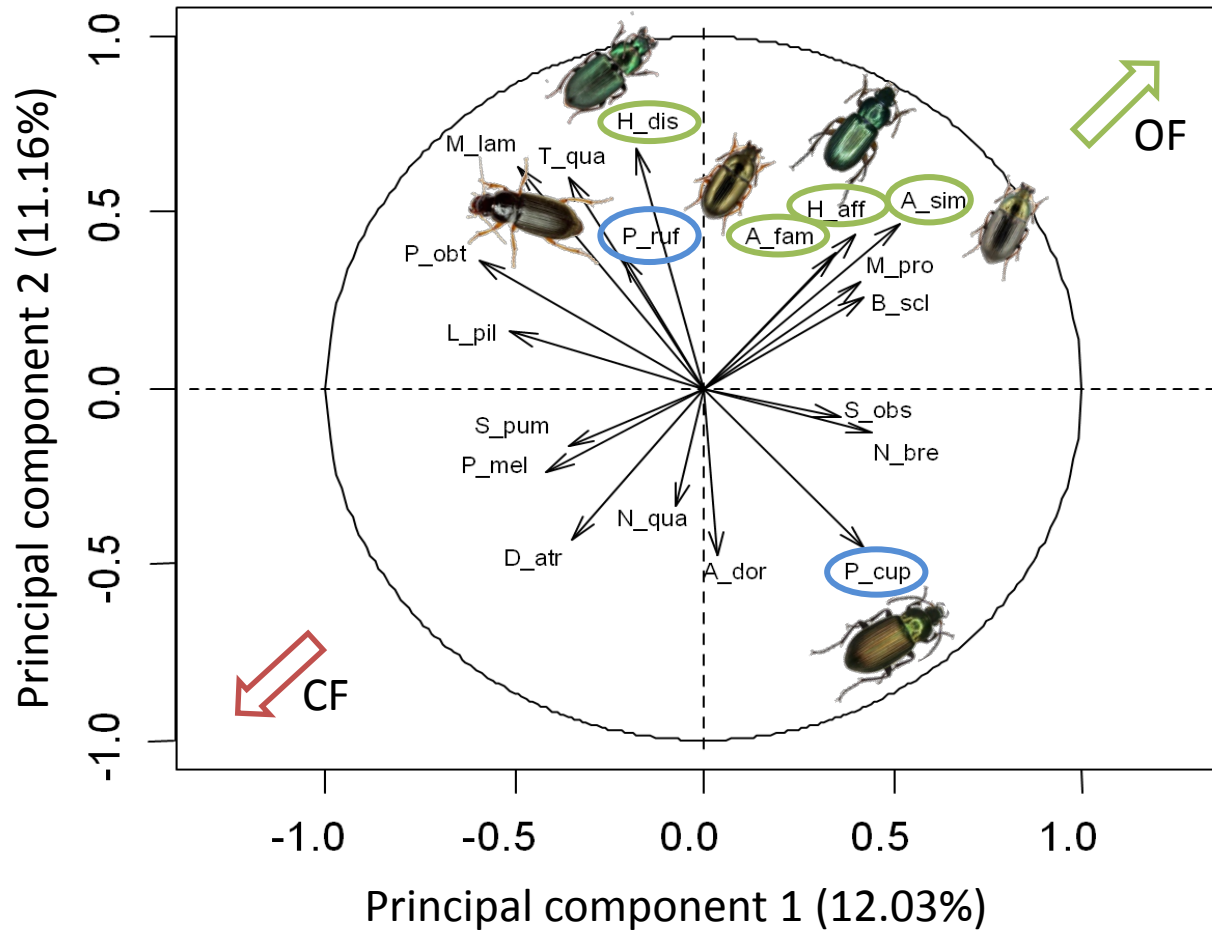


Organic farming :

- Rich vegetation cover

Results : Local scale

❖ Specific composition of ground beetle communities



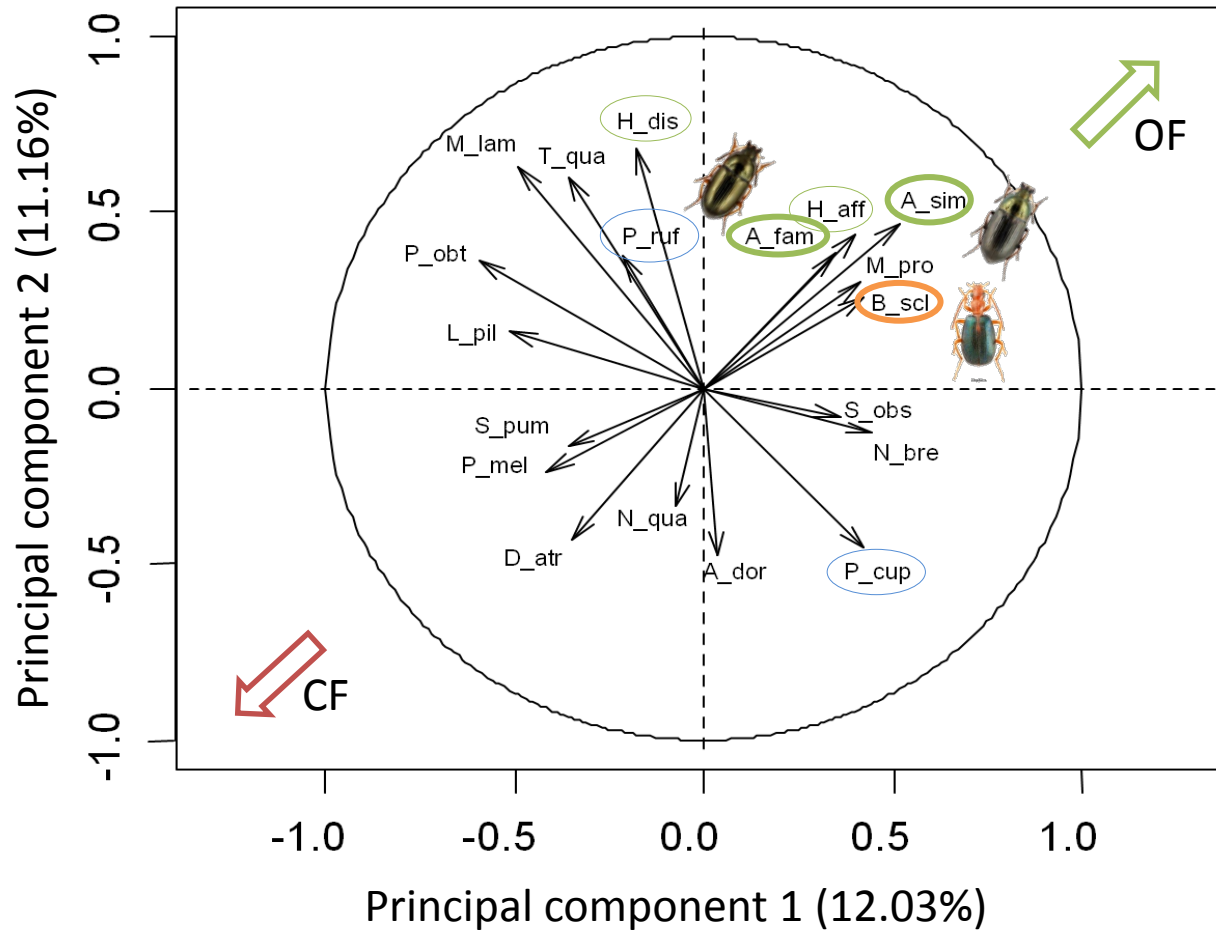
Organic farming :

- Rich vegetation cover

↳ phytophagous

Results : Local scale

❖ Specific composition of ground beetle communities



Organic farming :

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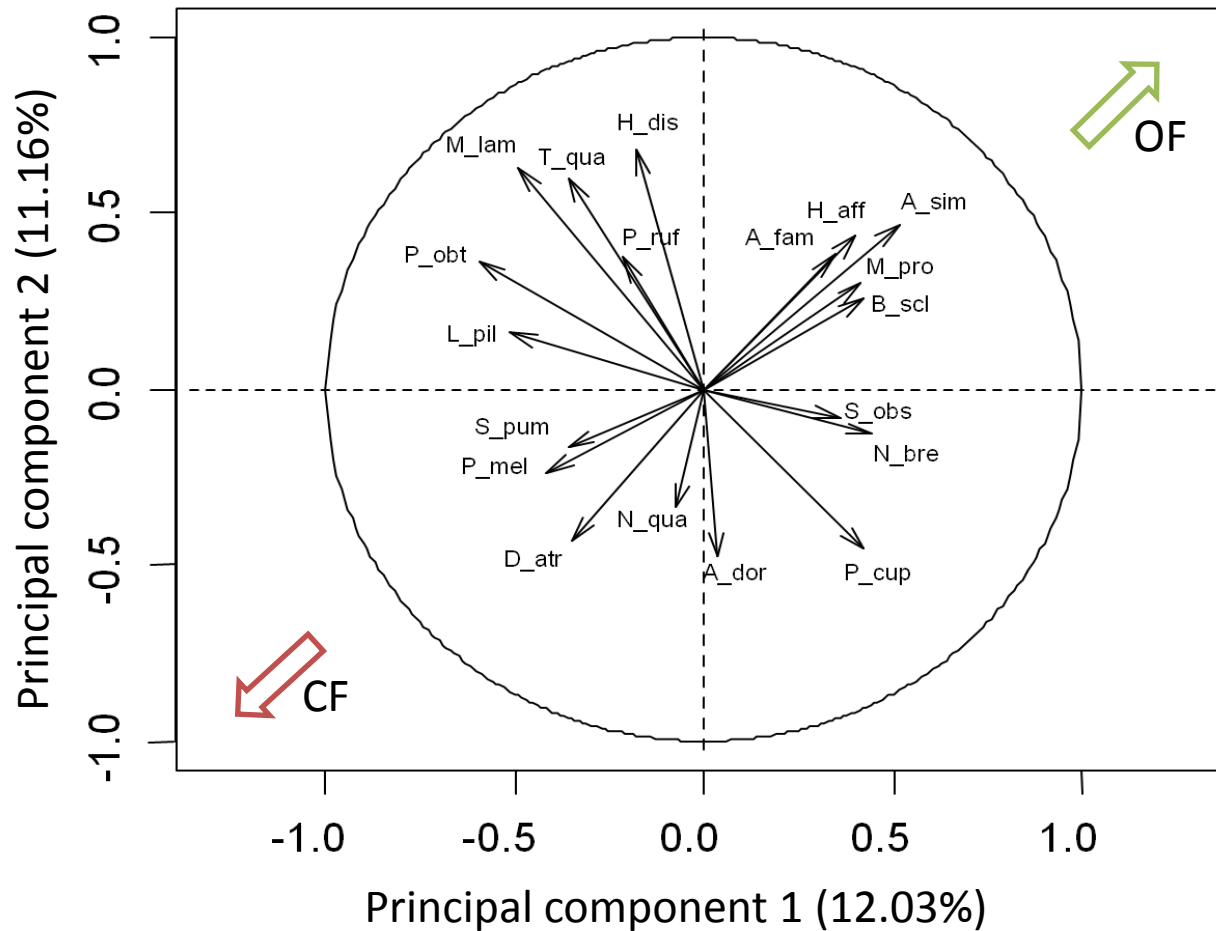
↳ phytophagous

- Genus *Amara*

↳ genus *Brachinus*

Results : Local scale

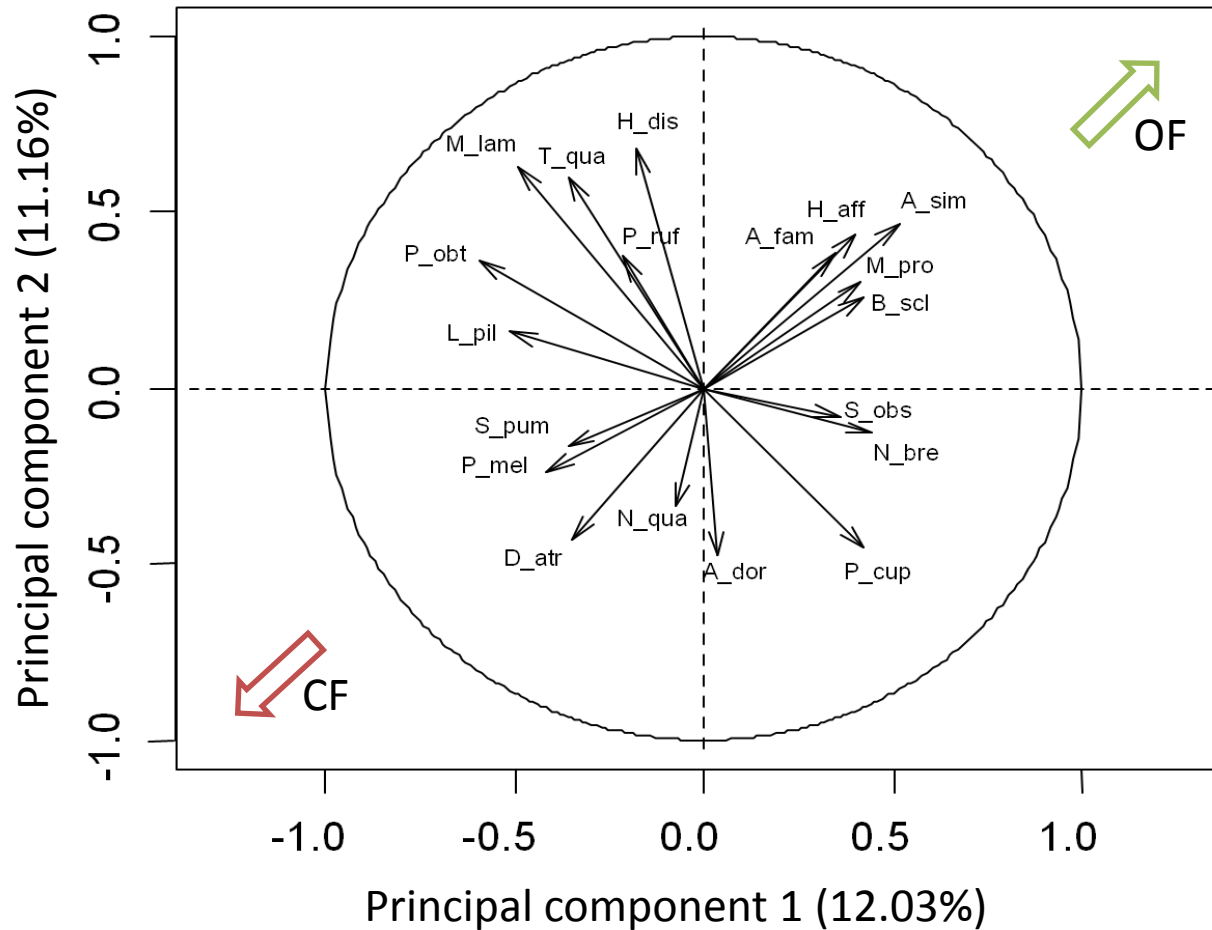
❖ Specific composition of ground beetle communities



Conventional farming :
- less diverse resources

Results : Local scale

❖ Specific composition of ground beetle communities



Conventional farming :

- less diverse resources

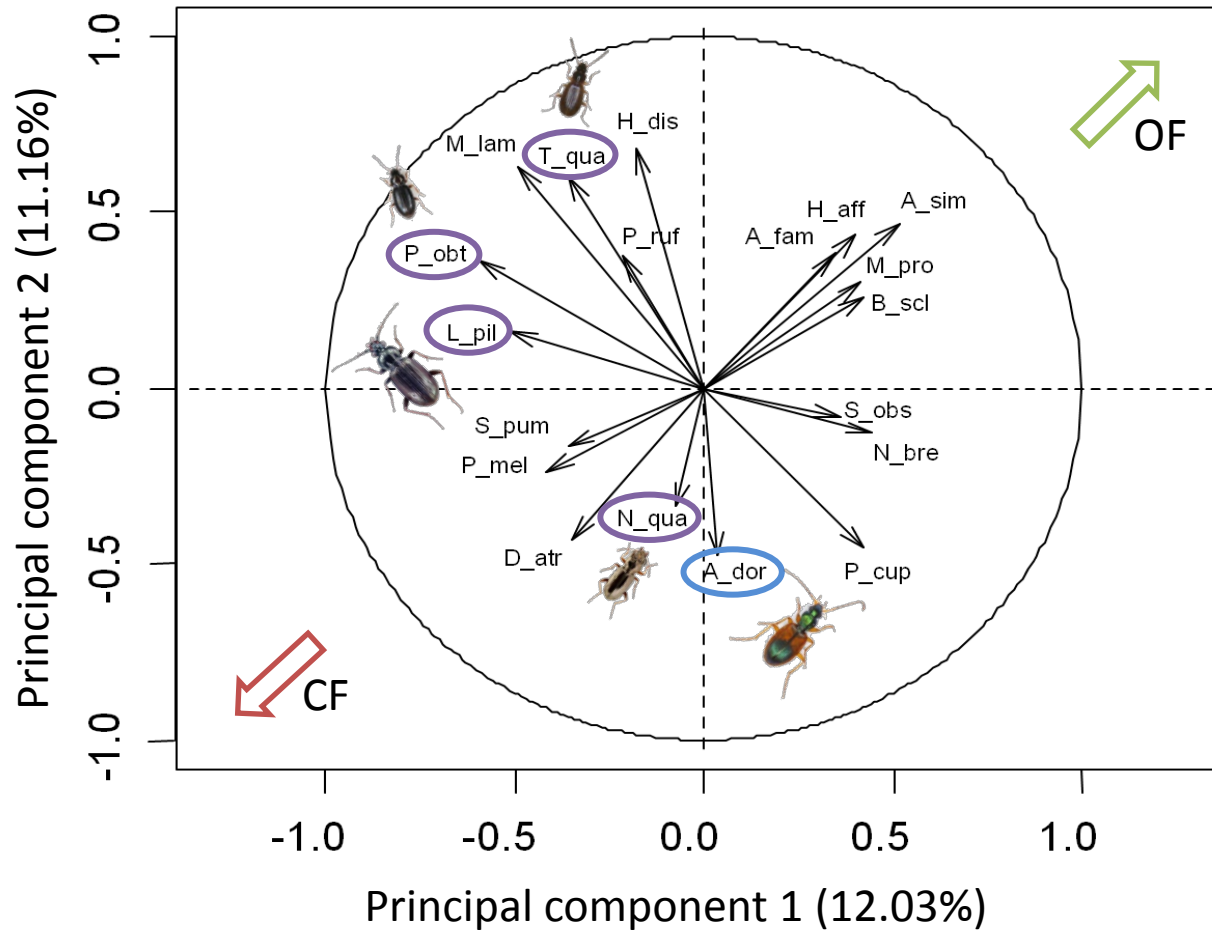
↳ collembola

↳ slugs

↳ aphids

Results : Local scale

❖ Specific composition of ground beetle communities



Conventional farming :

- less diverse resources

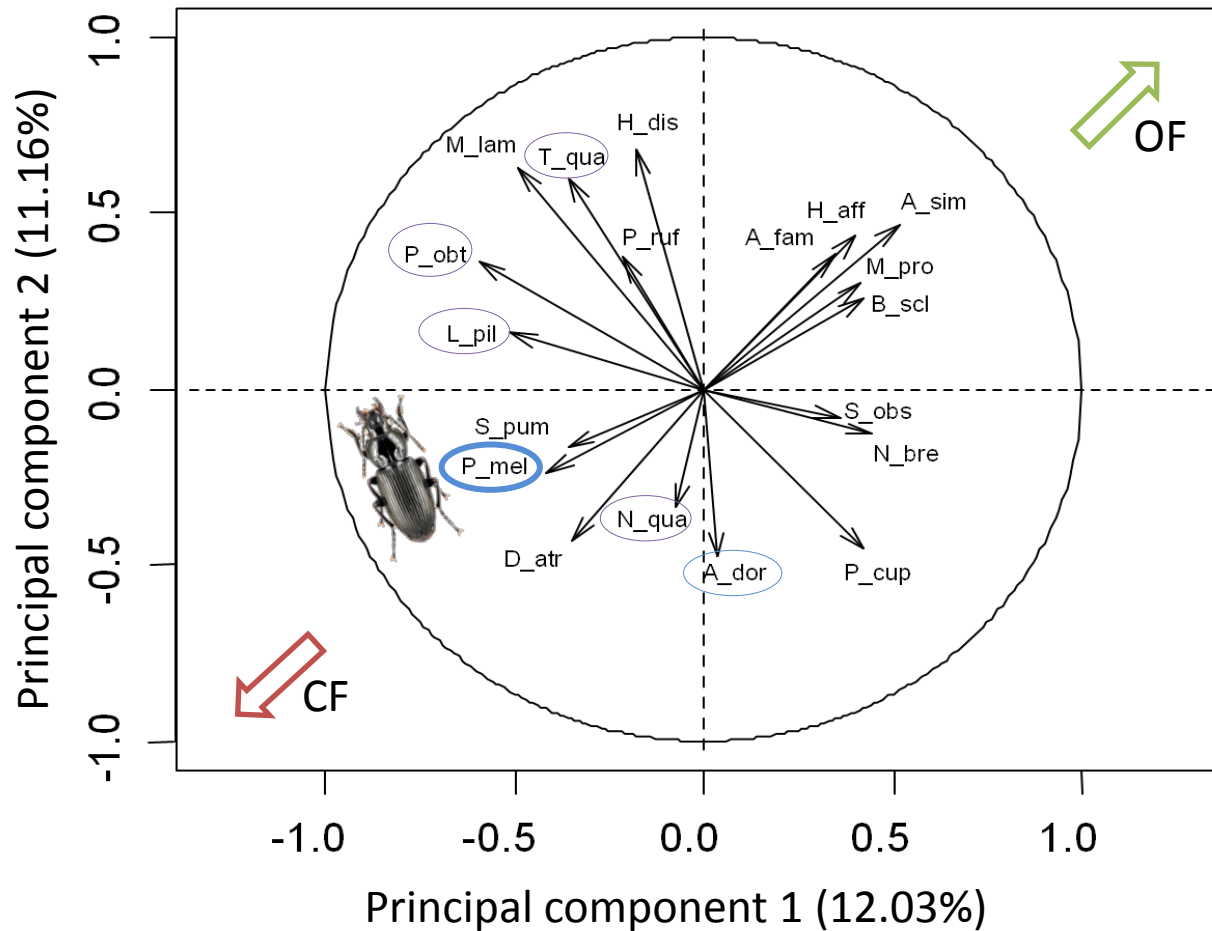
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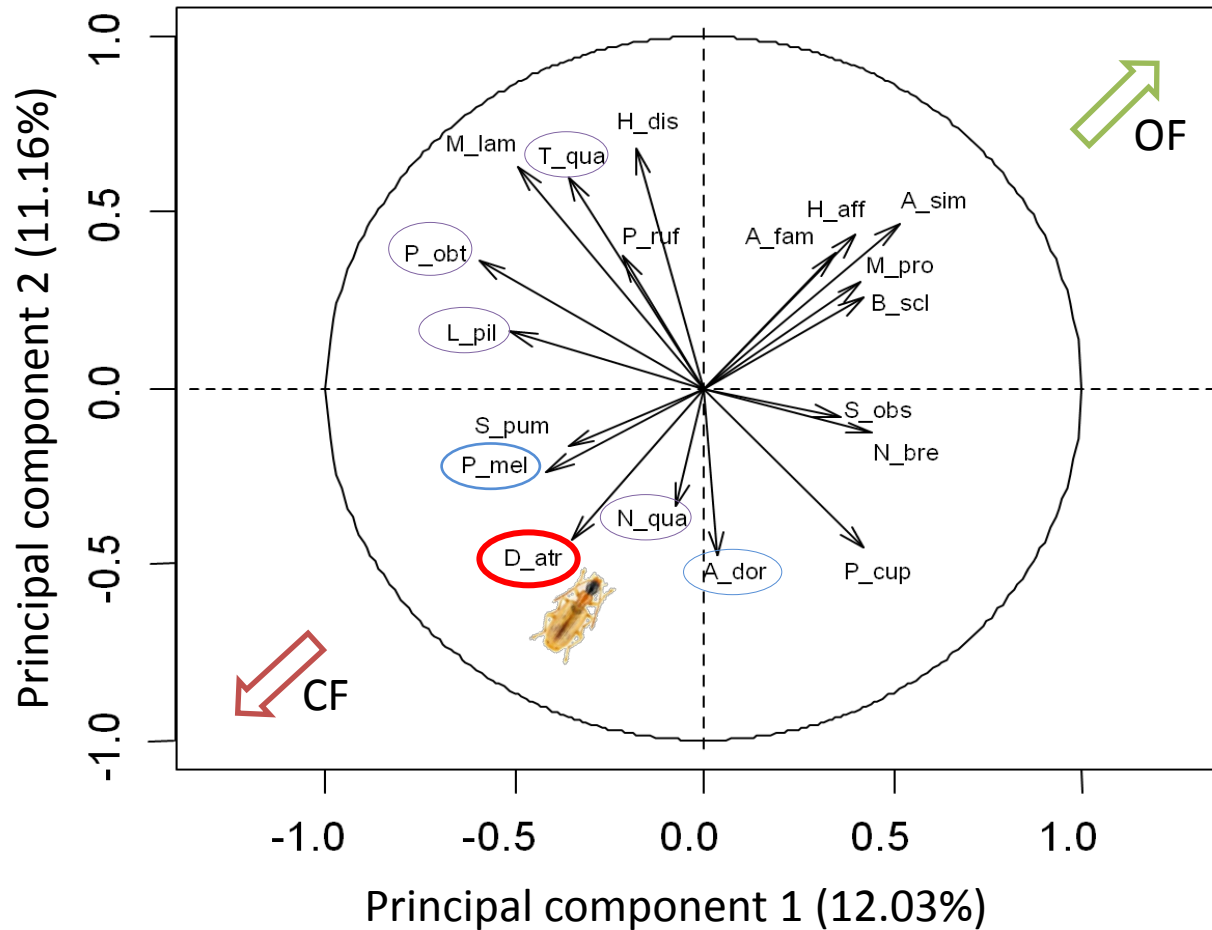
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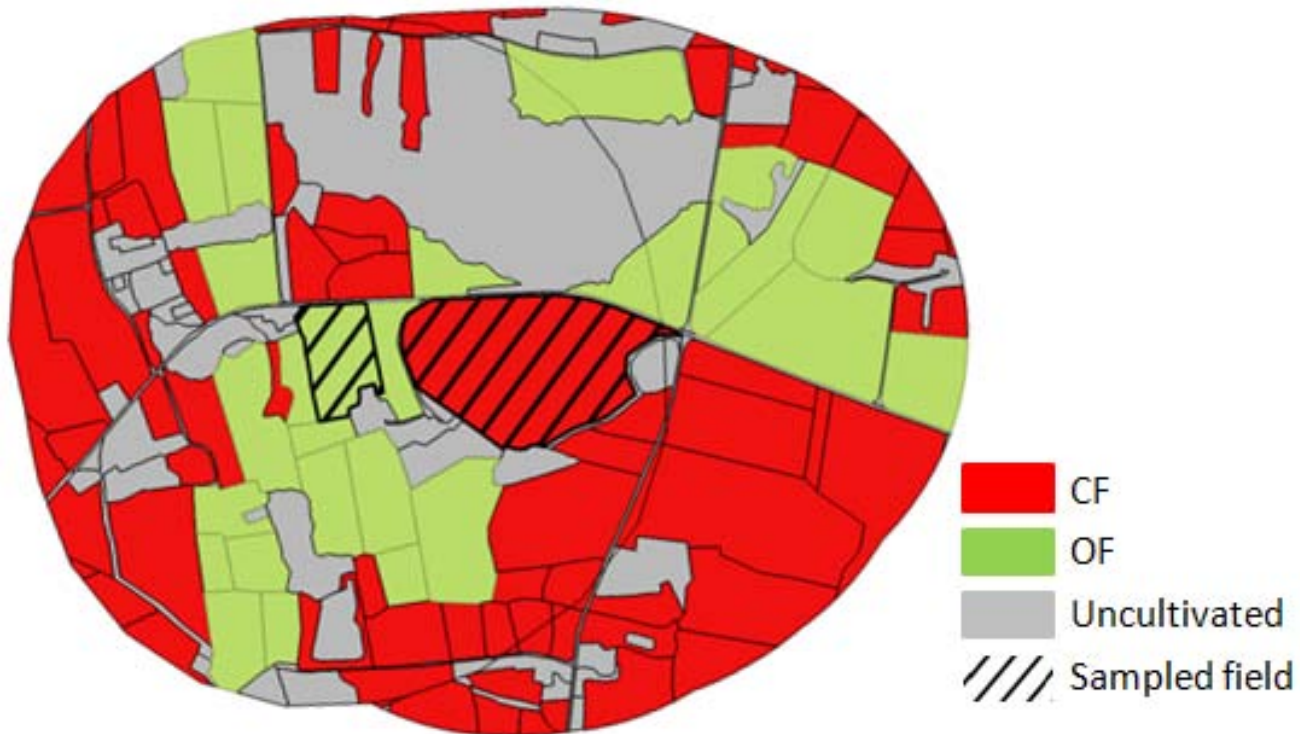
↳ aphids

Landscape scale

❖ Method

Cartography :

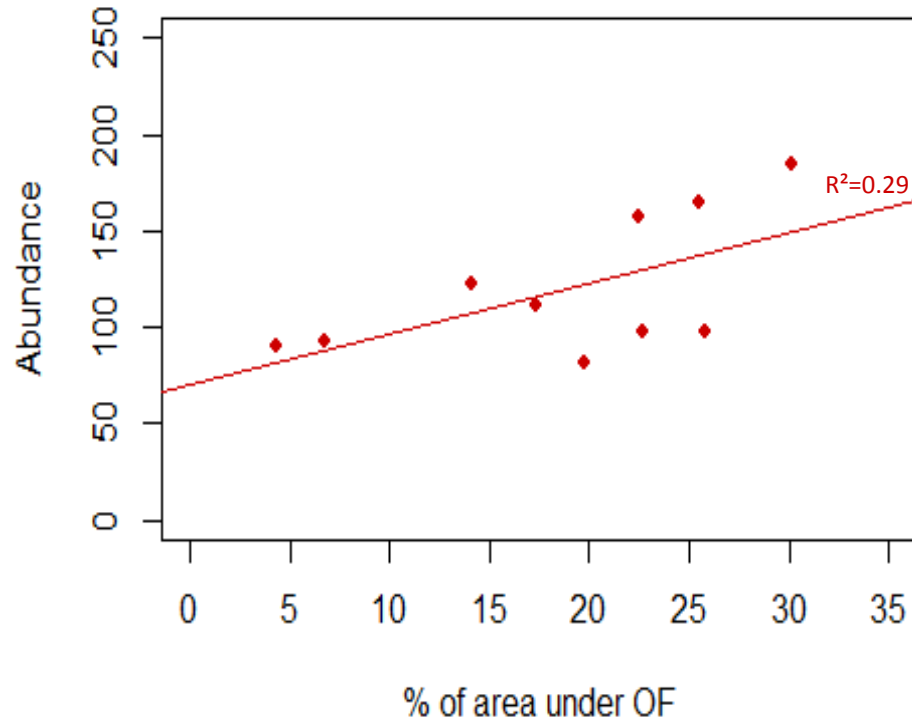
- Buffer of 500m around fields
- Information on crops management
 - ↳ OF gradient in the surroundings of sampling fields.



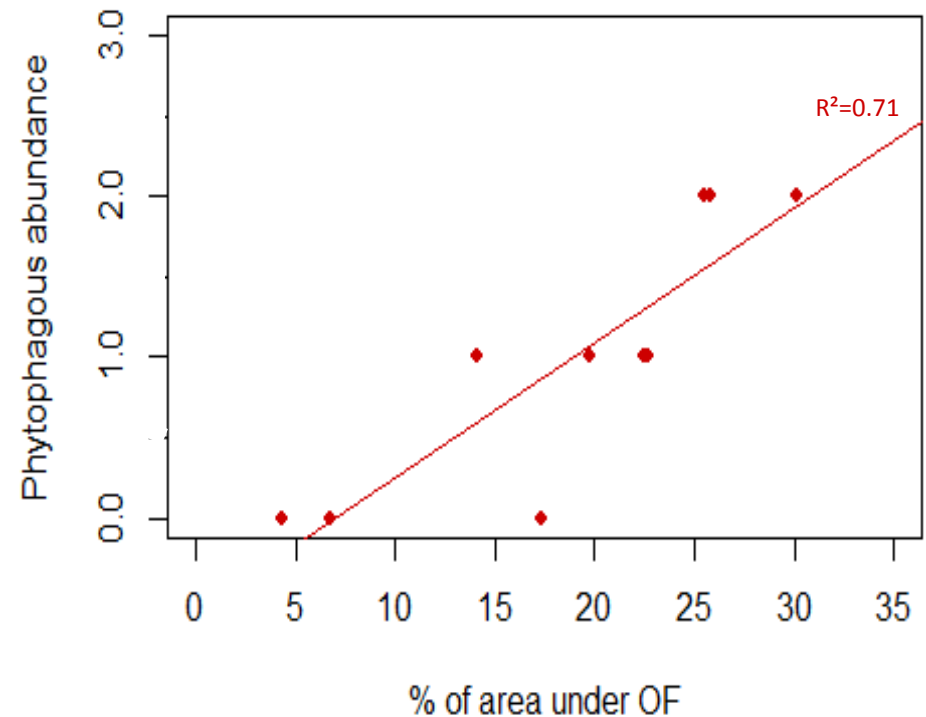
Results : Landscape scale

❖ 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

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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

Conclusions

➤ Differences in species composition :

- OF : phytophagous species
- CF : collembola eaters

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



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

➤ 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

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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

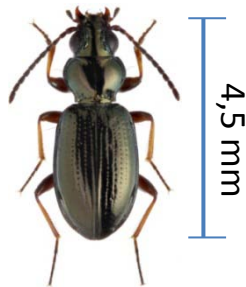
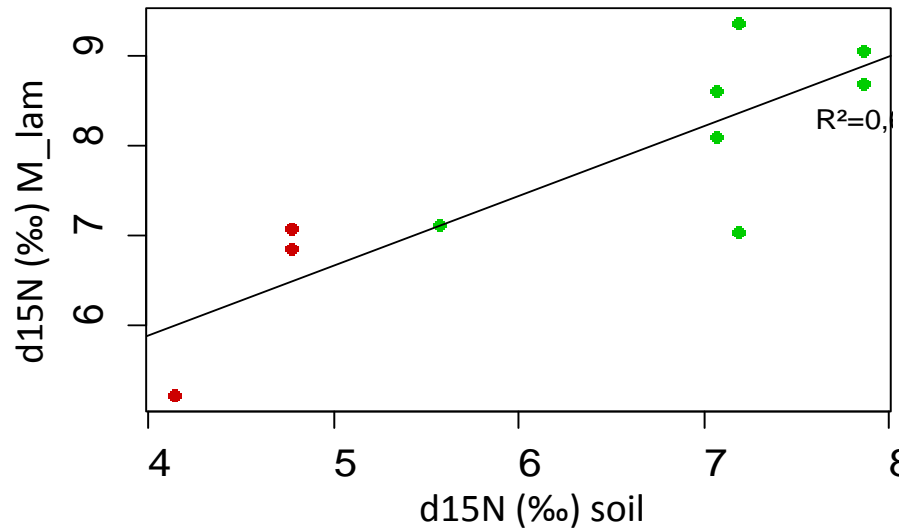
- Changes in soil's isotopic labelling :
 - differences in fertilization methods
 - differences in organic matter origin

- Isotopic labelling transmission from soils to ground beetle ?

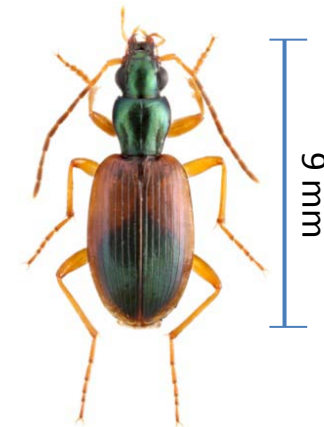
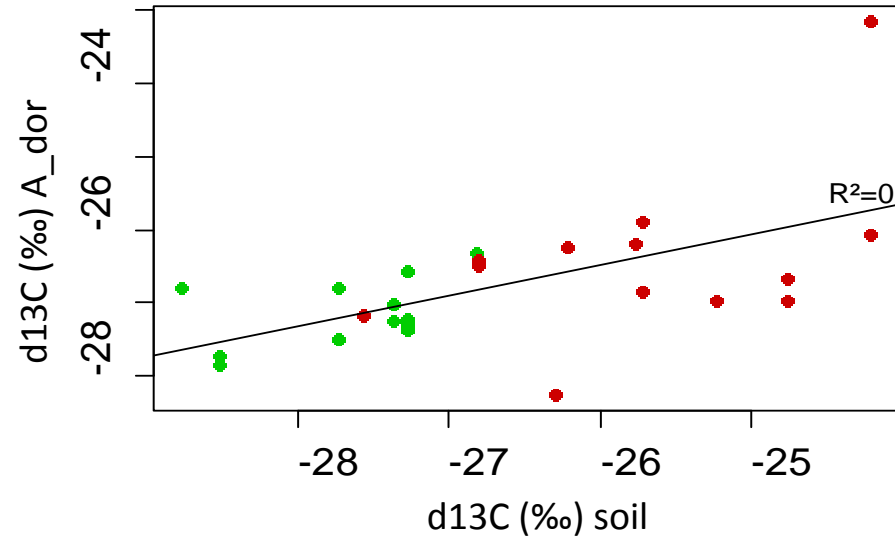
First results : Isotopic labelling

❖ 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 intraspecific 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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➤ Take into account:

- landscape features associated with **farming** systems
- 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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- sink in spring → attractiveness of crops
- source at farm scale → management and type of marginal areas
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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.

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

Thank you for your attention.

