# DNA-based monitoring of functional arthropod diversity: potential in tropical agroecosystems

Marcel Polling[1], Eric Rahn[2], Isabela Otero[2], Marieke Sassen[2,3]
[1]Animal Ecology, Wageningen Environmental Research, The Netherlands; [2]The Alliance Bioversity International and CIAT, Colombia; [3]Plant Production Systems, Wageningen University, The Netherlands

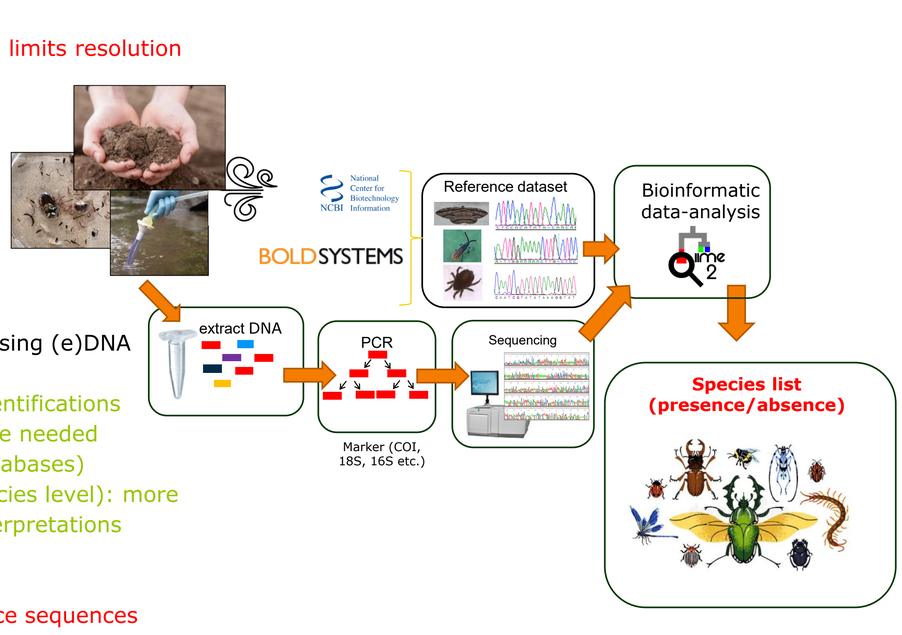
## Background

- **Functional insect diversity** supports resilient, productive agroecosystems and informs sustainable management.
- **DNA-based environmental monitoring** is increasingly seen as an alternative to traditional monitoring methods.
- We explore the potential for DNA-based insect monitoring in **coffee agroecosystems**.

## Methods

- Assess arthropod diversity across **ten coffee farms in Anserma (Caldas, Colombia)** comparing five large monoculture and five small diversified production systems.
- Combine standardized trapping of **flying and ground-dwelling arthropods** (SLAM/Malaise and pitfall traps) + sticky trap sampling, across wet and dry seasons.
- Use a **non-destructive DNA extraction protocol** to allow counting the arthropods post-extraction and COI metabarcoding (Figure 1).

Biodiversity monitoring the traditional way
- Extensive field work
- Manual identifications, limits resolution
- Abundances
- Life stages/gender




Biodiversity monitoring using (e)DNA metabarcoding
- Faster and cheaper identifications
- No taxonomic expertise needed (only for reference databases)
- Higher resolution (species level): more detailed ecological interpretations
- No abundances
- No life stages/ gender
- Dependent on reference sequences

**Figure 1.** Traditional vs (e)DNA based biodiversity monitoring.

## Results

### *A combination of traps is needed to fully capture insect diversity*

- Sampling method strongly determines observed community composition, with minimal overlap between the sample types (Figures 2 and 3).
- **Single-method approaches risk severely underestimating biodiversity.**

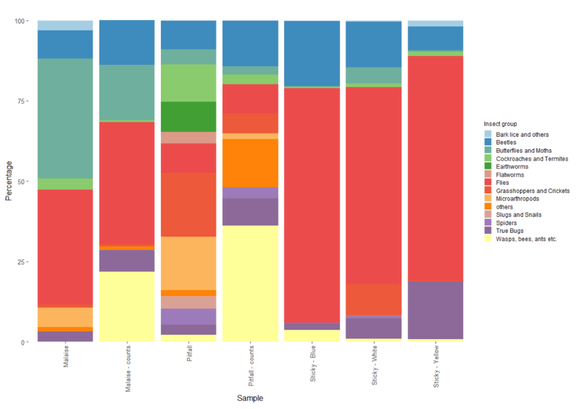



**Figure 2.** Relative composition of major arthropod groups captured by different sampling methods. For SLAM and pitfall traps, both specimen and sequencing read counts are shown

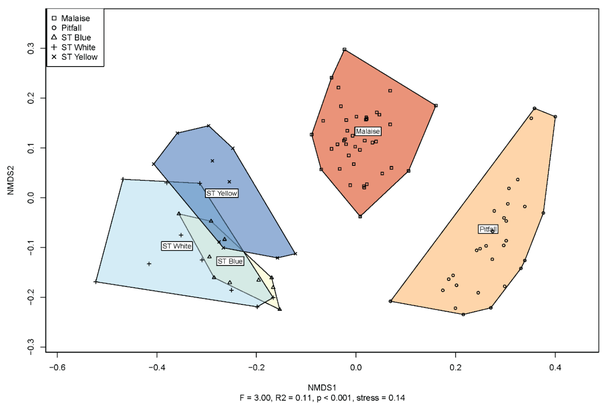



**Figure 3.** NMDS ordination of insect community composition by trap type identified using DNA metabarcoding. Points represent individual samples. Polygons indicate group dispersion.

### *Arthropod diversity in monoculture vs diversified farms*

- **Substantial arthropod diversity in coffee systems**: 1,870 taxa across 36 orders.
- No significant difference in local (alpha) diversity.
- **Management effects emerge primarily at larger spatial scales.**

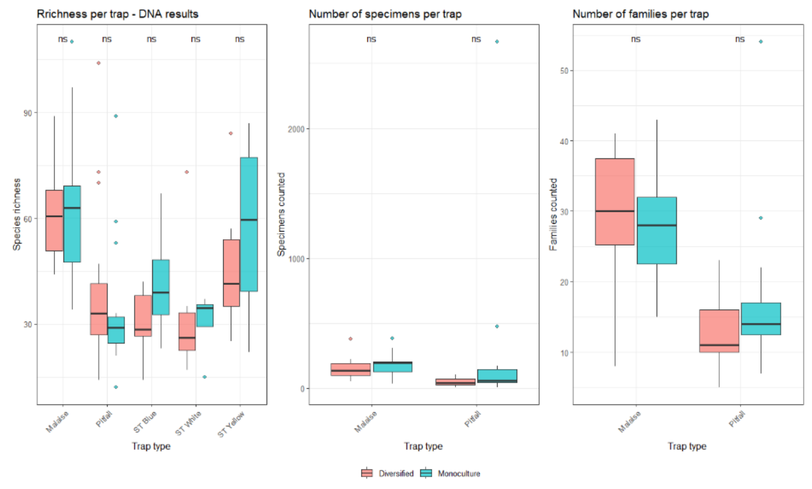



**Figure 4.** Comparison of species richness among arthropod functional groups between diversified and monoculture farms

### *Coffee management and functional diversity*

- Despite undersampling: **significantly higher total diversity (gamma)** in diversified coffee farms (Figure 5).
- Most captured arthropods were **detritivores**: key role in decomposition and nutrient cycling (soil fertility).
- More detritivores in diversified farms, but more parasitoids and pollinators in monocultures (Figure 6).

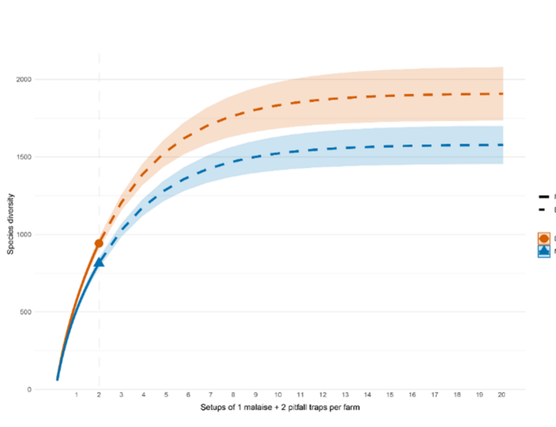



**Figure 5.** Taxa diversity as a function of sampling effort (number of trap setups per farm) for diversified and monoculture farms.

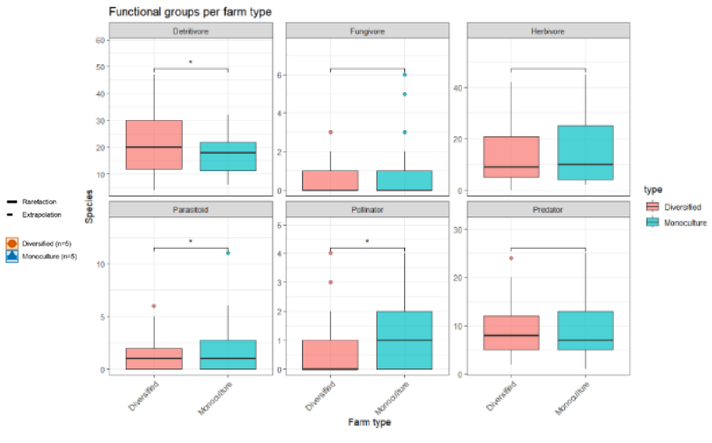



**Figure 6.** Comparison of species richness among arthropod functional groups between diversified and monoculture farms.

## Conclusions

- DNA-based monitoring can deliver robust biodiversity indicators for tropical agroecosystems, provided it integrates complementary sampling and appropriate analytical frameworks.
- **Limited reference databases** remain a key constraint and future work should incorporate the generation of this type of baseline data.
- Diversified coffee farms in Anserma, Colombia support significantly higher overall insect diversity, but not necessarily greater functional diversity.

## Acknowledgements

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**Wageningen University & Research**
Contact: Marieke.Sassen@wur.nl
https://www.wur.nl/en/

**The Alliance of Bioversity International and CIAT**
Contact: E.Rahn@cgiar.org
https://alliancebioversityciat.org/