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# Exposure to pesticide mixtures does not affect locomotory behaviors in carabid beetles

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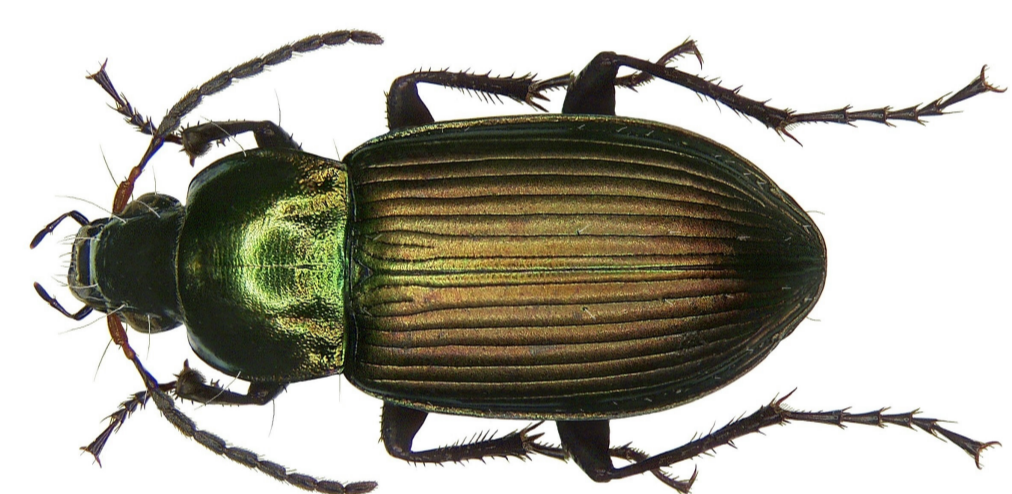
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## Carabids do not vary on average with exposure but behavioral variability does

### 1 Context

- Pesticides have deleterious effects on life-history, physiology and behavior in non-targeted organisms<sup>1-2</sup>
- Behavioral assays use substance-by-substance approaches that ignore cocktail effects in the field<sup>3</sup>
- Need novel procedures that account for multiple exposures

**Objective:** Determine the effect of pesticide multi-residue exposure on activity and exploration at field-realistic concentrations

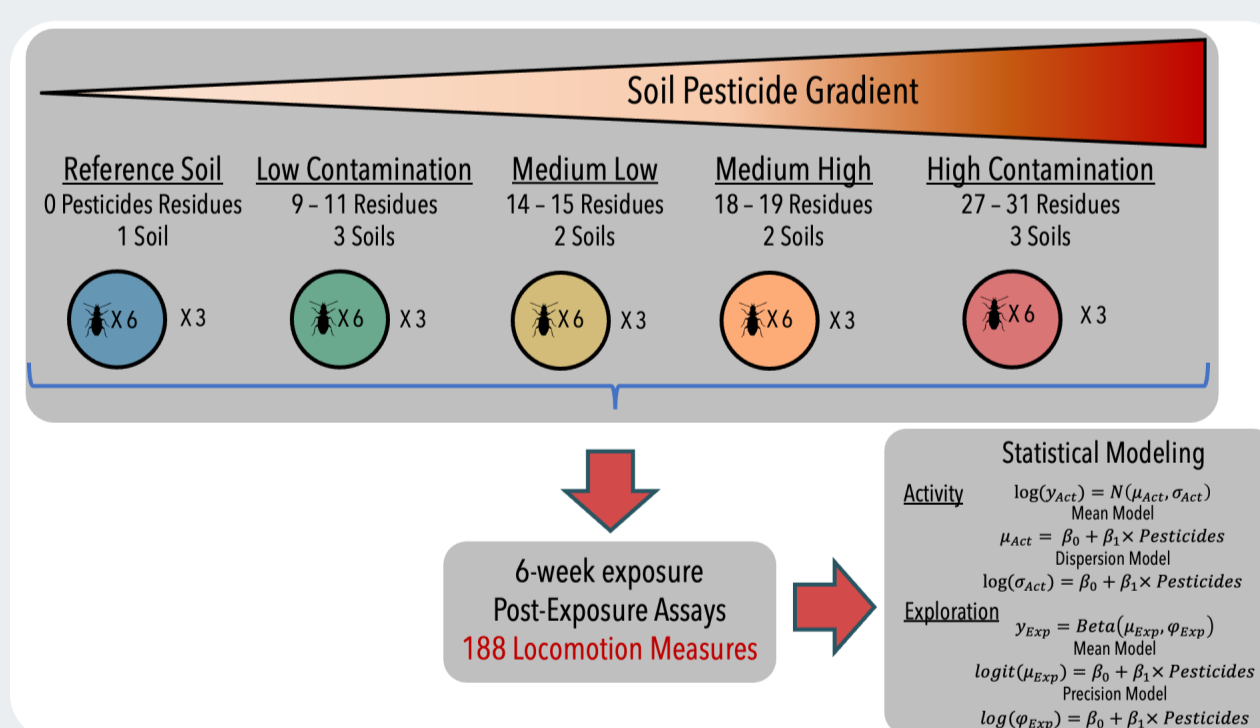


**Fig 1.** *Poecilus cupreus*, a common generalist carabid predator in agorecosystems

### 2 Methods

#### Pesticide exposure

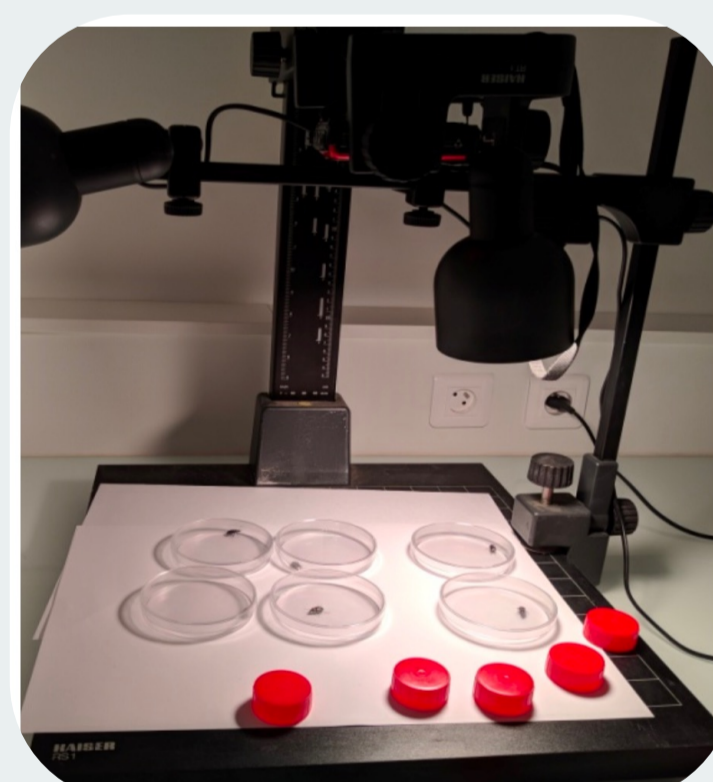
- 10 agricultural soils
- 1 reference soil
- 198 carabids exposed



**Fig 2.** Carabids were exposed to a gradient of soil pesticide contamination during 6 weeks. Soils were chosen to have similar physico-chemical properties.

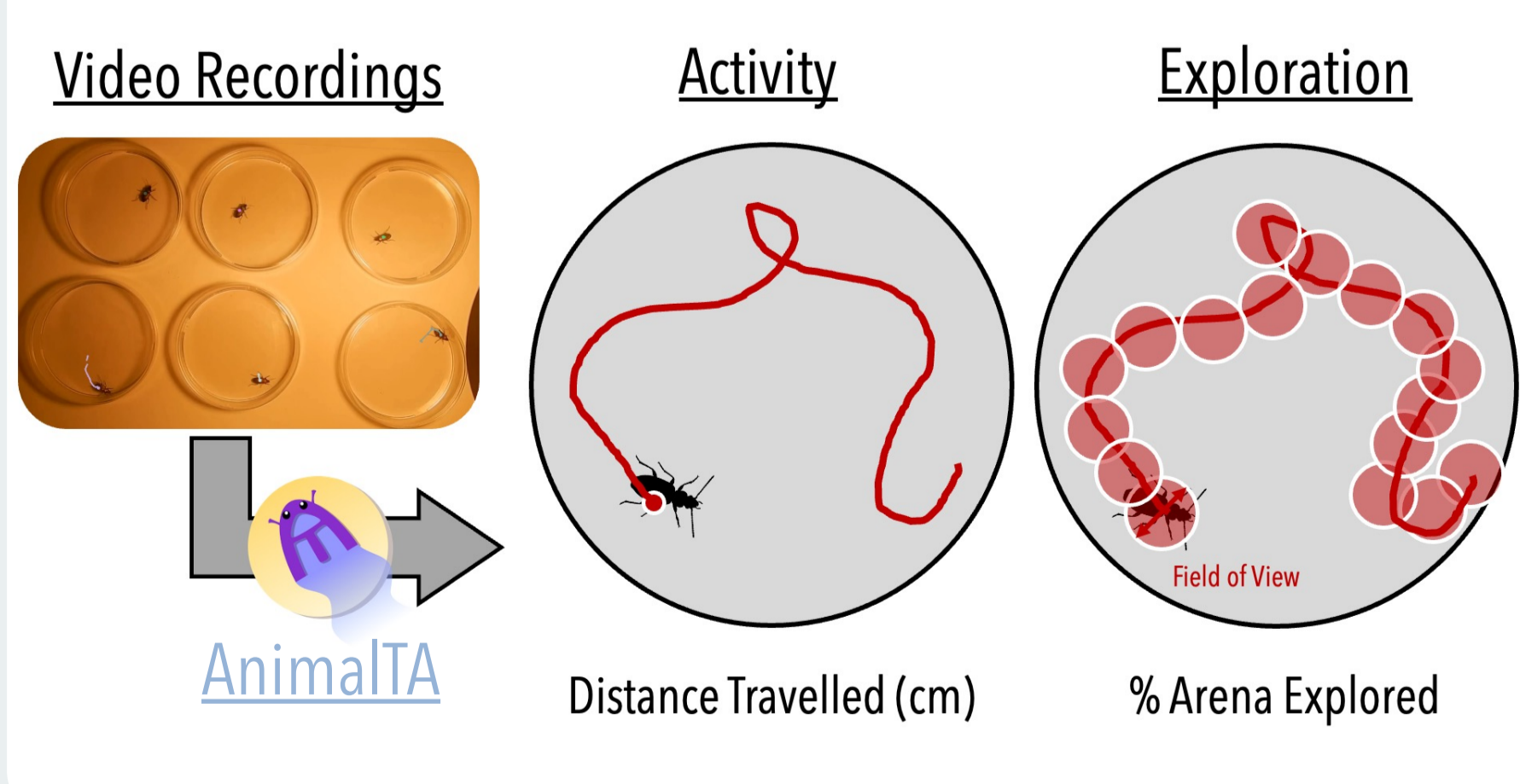
#### Biological responses

- Body-mass
- Reproduction
- Righting ability
- Predation efficiency
- **Locomotion**



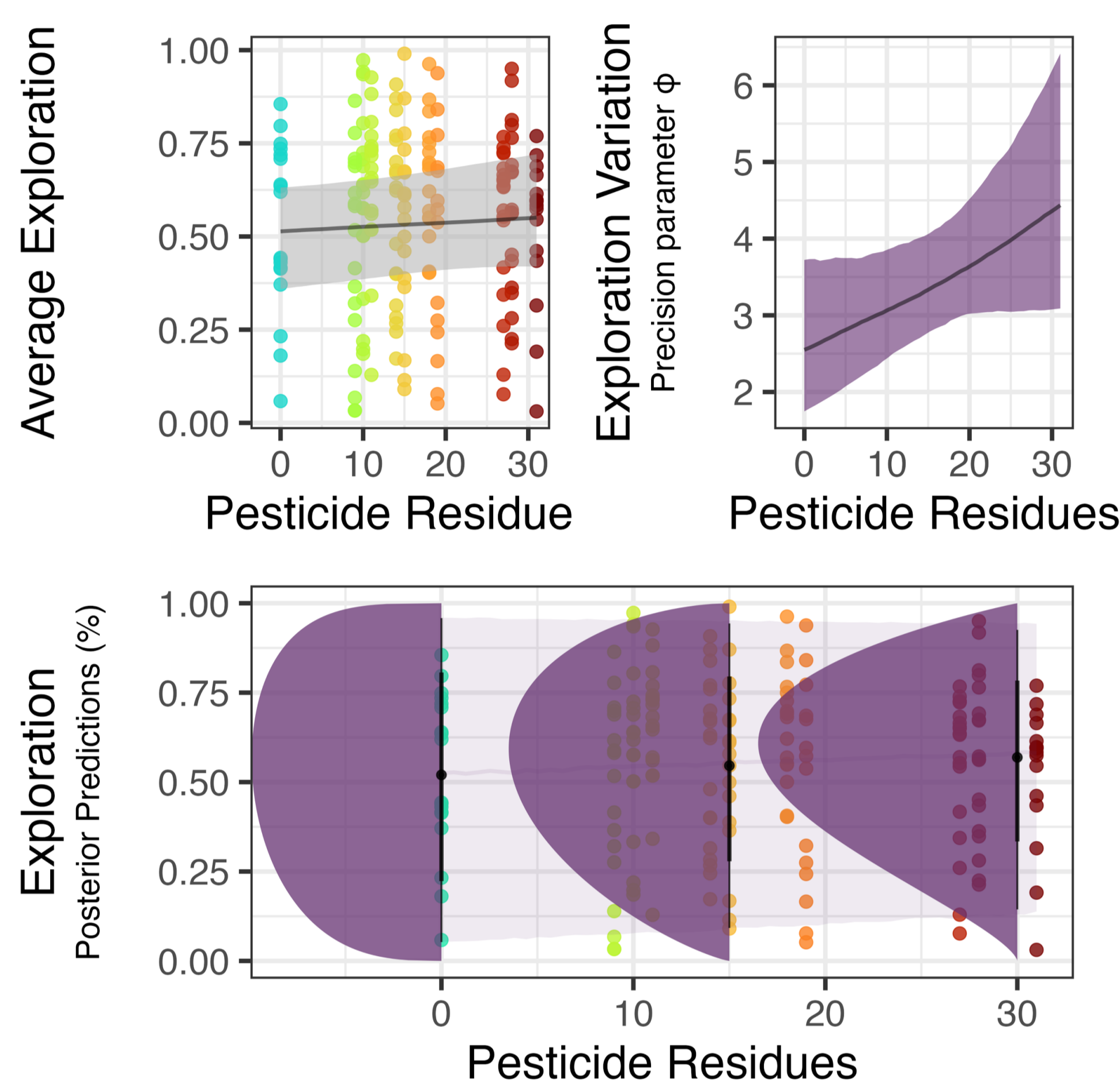
**Fig 3.** We monitored carabid locomotion in 10-minute assays using 9cm Petri dishes as arenas.

#### Video Tracking Analysis



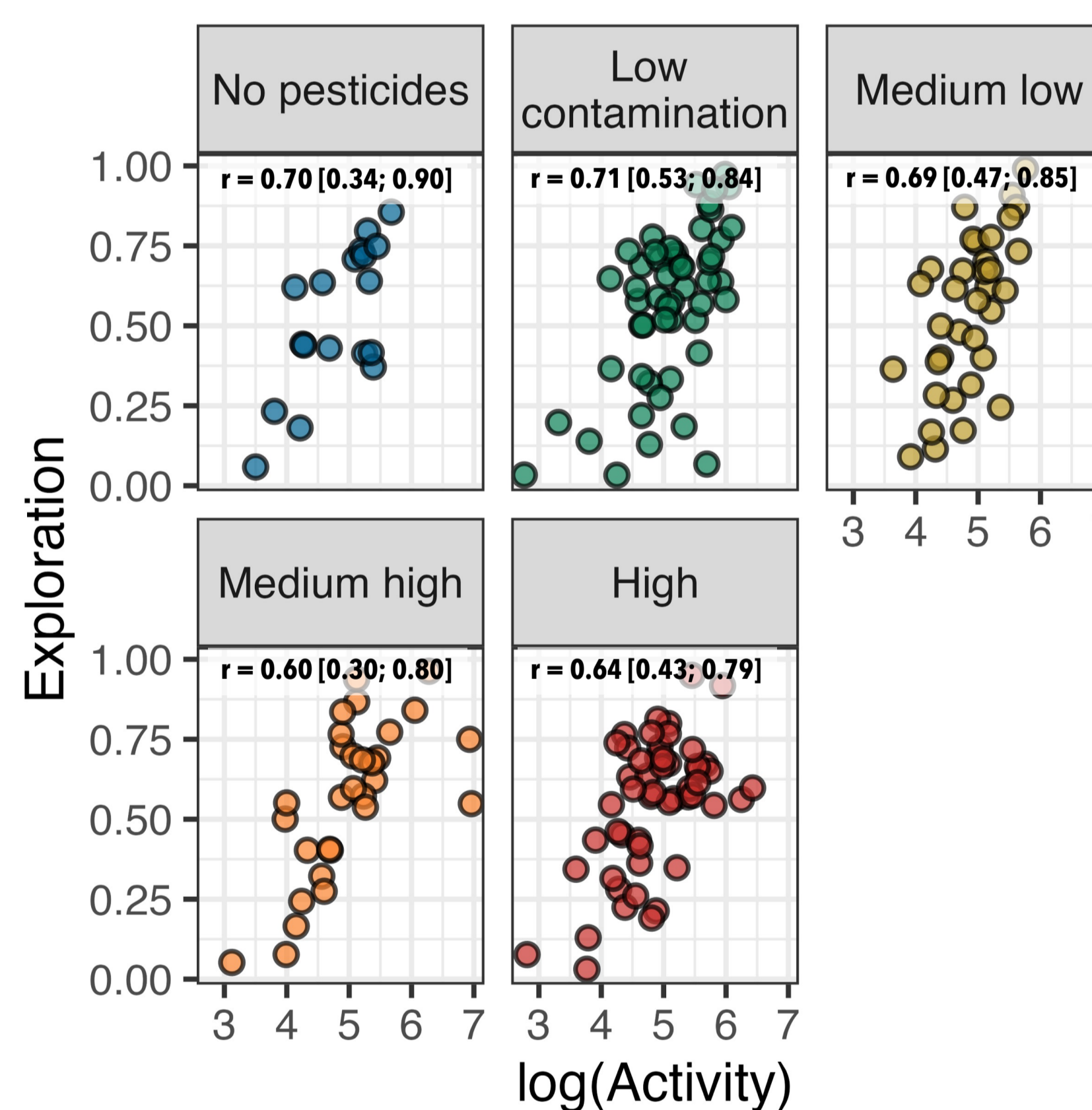
**Fig 4.** We used an automated video-tracking software to digitize animal tracks and extract activity (total distance travelled) and exploration (% of arena explored).

### 3 Résultats



**Fig 5.** Effect of the number of pesticide residues in soils on carabid exploratory behavior. Top left, the number of residues had little influence on average exploration ( $\beta_{1, \mu} = 0.01 [-0.01; 0.02]$ , Probability of Direction,  $P_d = 0.82$ ). Top right, the precision parameter increases with residue number meaning that exploration variance tends to shrink at higher exposures ( $\beta_{1, \phi} = 0.02 [0.00; 0.04]$ ,  $P_d = 0.95$ ). Bottom, posterior prediction indicating the shifts in exploration mean and precision as pesticide exposure increases. Results based on a Bayesian Linear Hierarchical Model fitted with [bms](#).

- No effects on activity
- Exploration variability decreases with exposure



**Fig 6.** Correlation between activity and exploration compared across 4 levels of pesticide soil contamination. No effects of contamination class on behavioral correlations were detected (Probability of Direction,  $P_d < 0.74$ ). Results based on Bayesian Multivariate Hierarchical Models fitted with [bms](#).

- Strong Activity x Exploration syndrome
- No influence of soil contamination on behavioral correlations

### 4 Perspectives

- No overall effect of pesticides on locomotory behaviors
- Quantify pesticide concentrations for more precise inference
- Explore ingestion route as potentially more potent
- Use pose-tracking to detect fine-scale behavioral alterations

