



Effect of phytochemicals on cyathostomins ecological interactions

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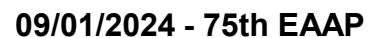
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#These authors contributed equally to this work

Cyathostomins life cycle and infection-induced clinical effects



- **Cyathostomins control is essential for equine industry**

Introduction

Cyathostomins have evolved to become resistant to most compounds

Fenbendazole

Pyrantel

Ivermectin or
Moxidectin

Ecoto

High resi

**Need for alternative
solutions to chemical
treatment!!**



Worldwide cases of macrocyclic lactone resistance

von Samson-Himmelstjerna *et al.*, 2007; Traversa *et al.*, 2012; Peregrine *et al.*, 2014; Relf *et al.*, 2014, Nielsen *et al.*, 2020; Abbas *et al.*, 2021; Lignon *et al.*, 2021; Nielsen *et al.*, 2020, 2022; Nielsen, 2022;

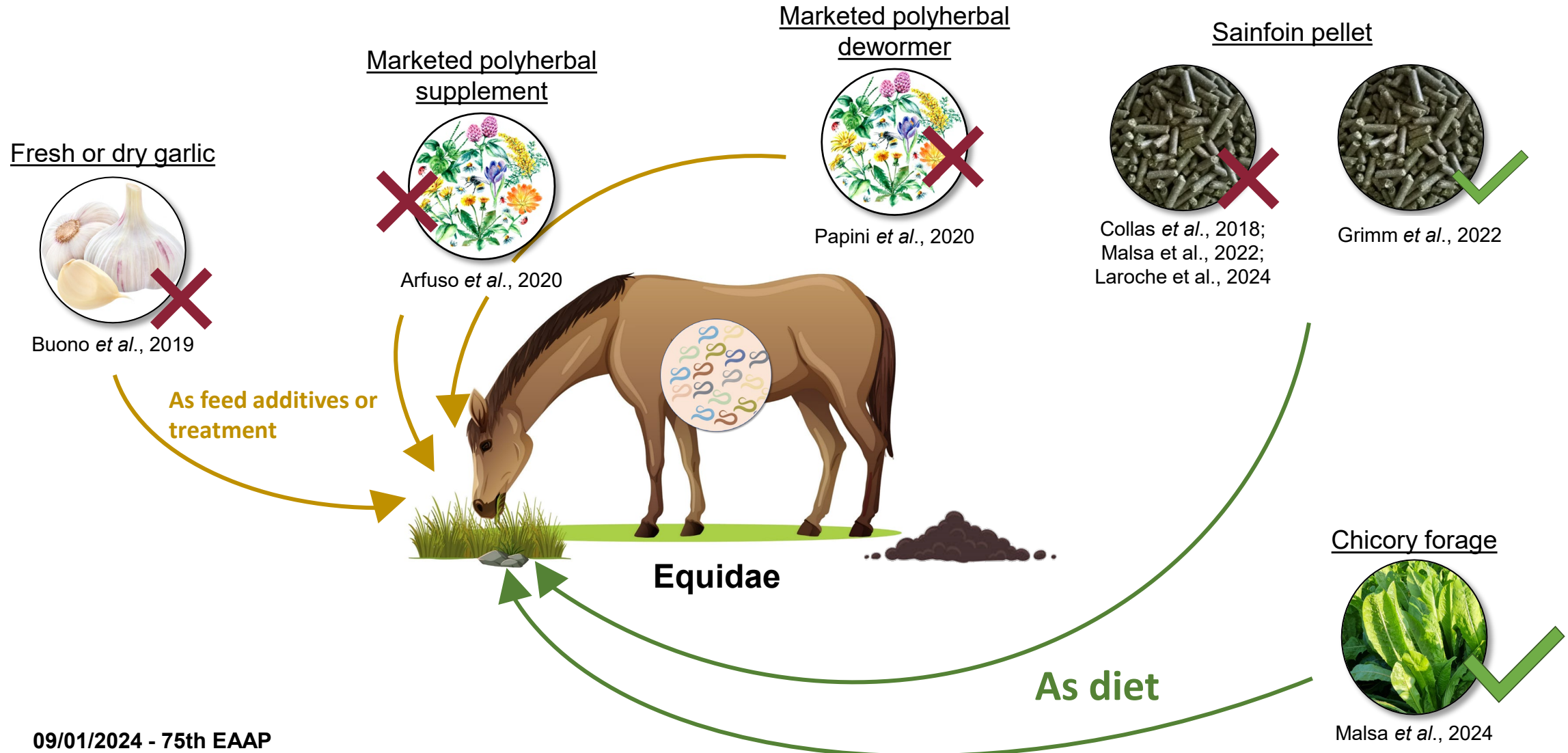


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**Drug-associated
environmental side effects**
(Lumaret *et al.*, 2012)

Introduction

Variable results from studies investigating alternative plant-based treatments



Introduction

Cylicostephanus longibursatus and *Cylicostephanus minutus* were less affected by the chicory diet

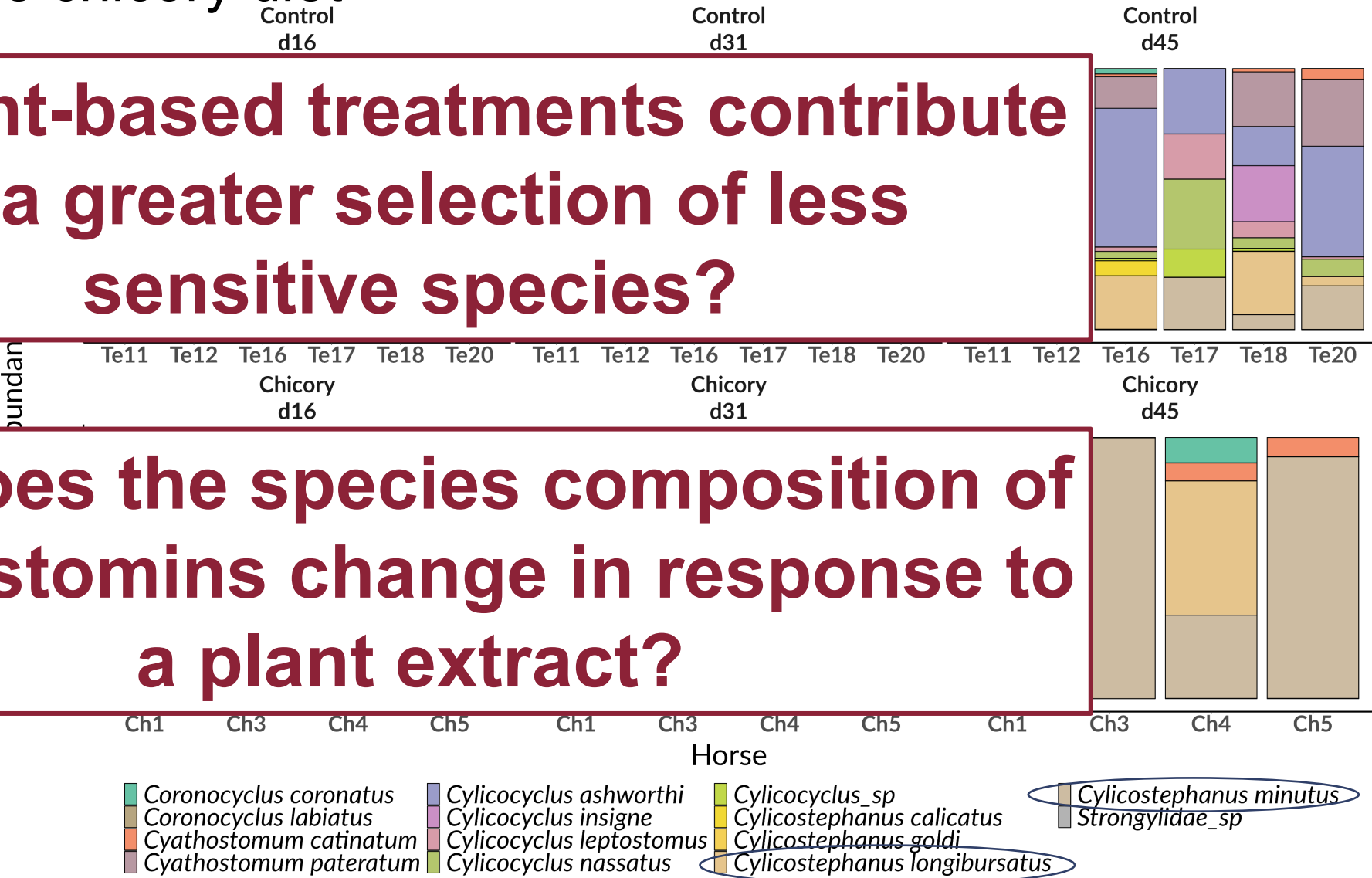
Chicory forage
(*in vivo* study)



Malsa *et al.*, 2024

Do plant-based treatments contribute to a greater selection of less sensitive species?

How does the species composition of cyathostomins change in response to a plant extract?



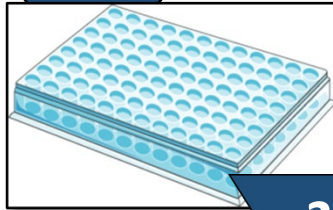
Method

In vitro screening of plant extracts on the basis of their direct and indirect activity



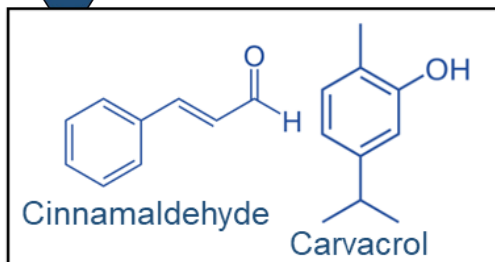
Literature investigation

29
compounds



Screening for *in vitro* antiparasitic

2



Cinnamon

Source of cinnamaldehyde

- Inhibition of egg hatching in the small ruminant strongyles

(Zhu *et al.*, 2013; Katiki *et al.*, 2014, 2017; Ferreira *et al.*, 2016; André *et al.*, 2017; 2017; Silva *et al.*, 2018)



Oregano

Source of carvacrol

- Inhibition of egg hatching in the small ruminant strongyles

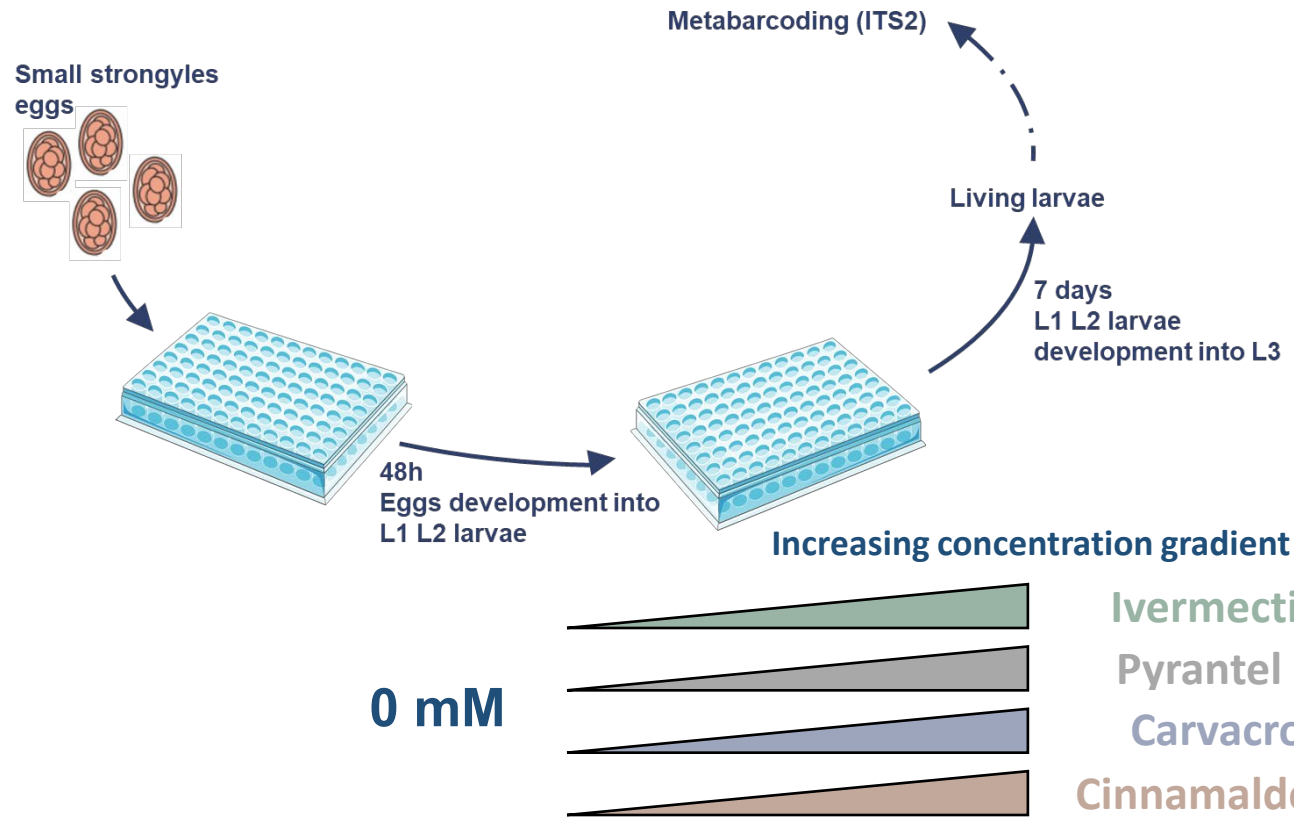
(Zhu *et al.*, 2013; Katiki *et al.*, 2014, 2017; Ferreira *et al.*, 2016; André *et al.*, 2017; 2017; Silva *et al.*, 2018)

- Larval development inhibitory activity

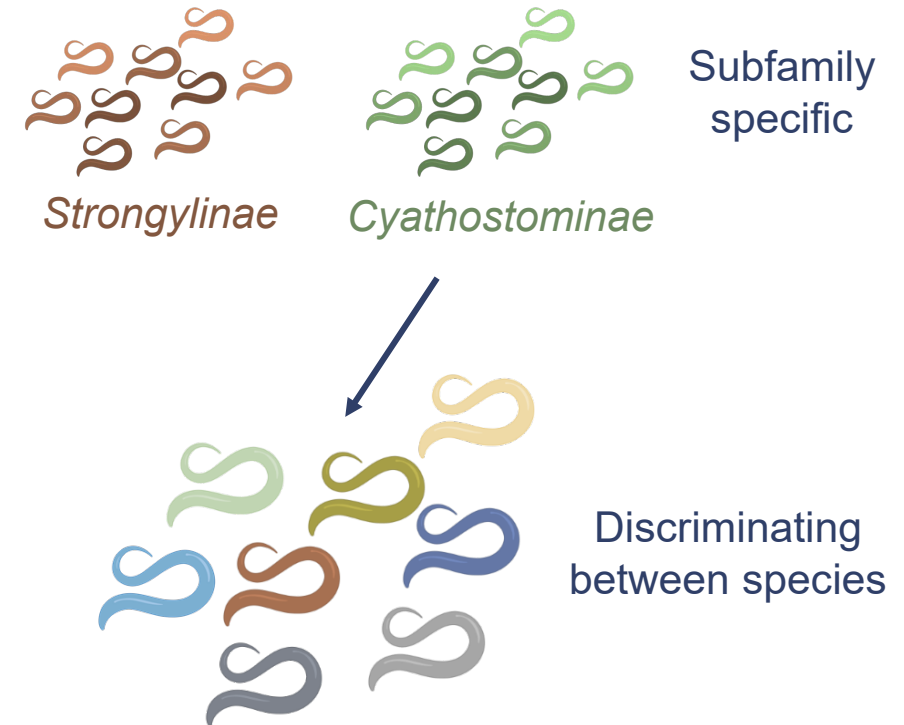
(Zhu *et al.*, 2013; André *et al.*, 2016, 2017; Ferreira *et al.*, 2016)

Method

Evolution of species composition across a concentration gradient of ivermectin, pyrantel, carvacrol and cinnamaldehyde

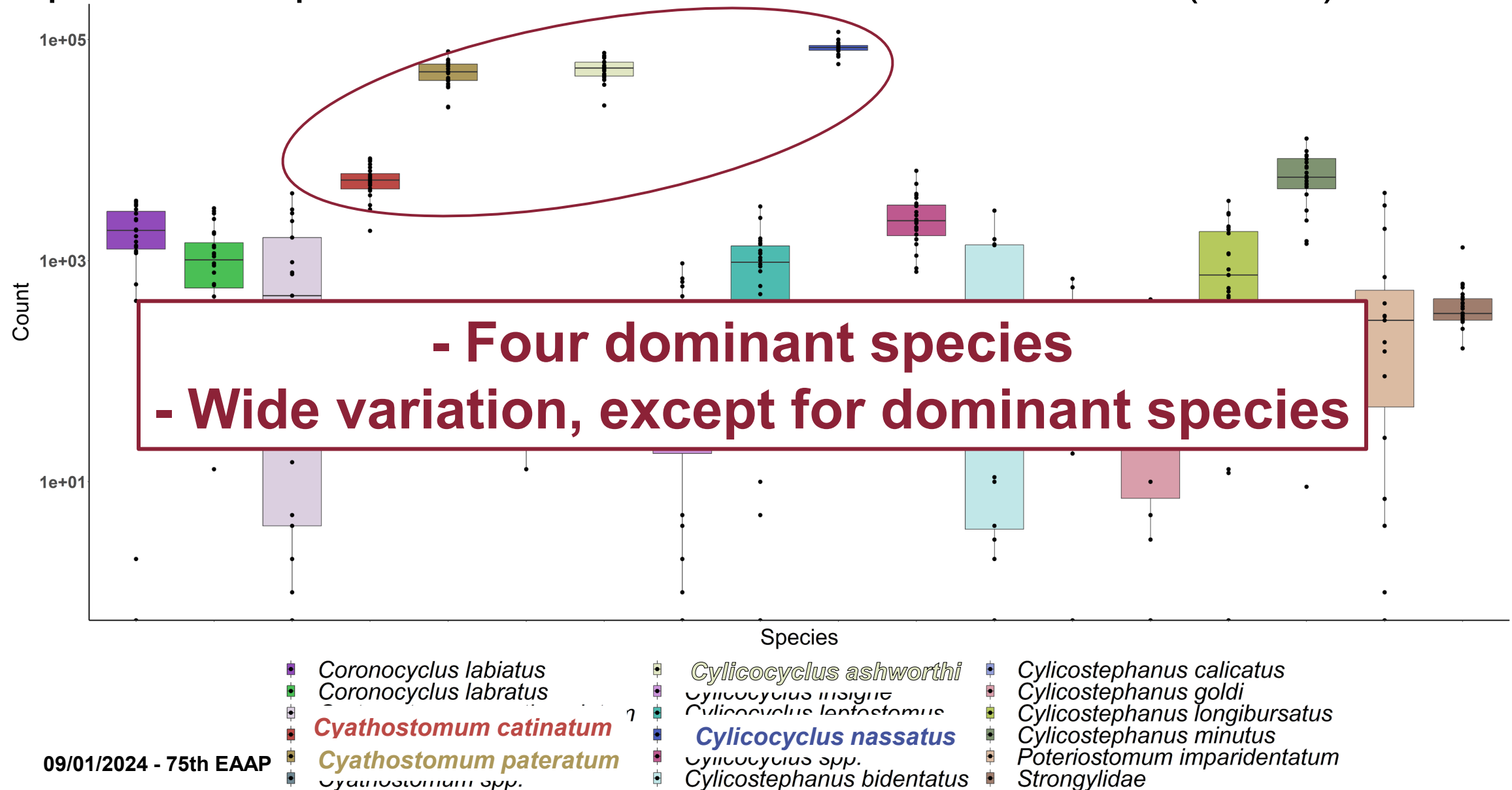


Metabarcoding approach (ITS2)



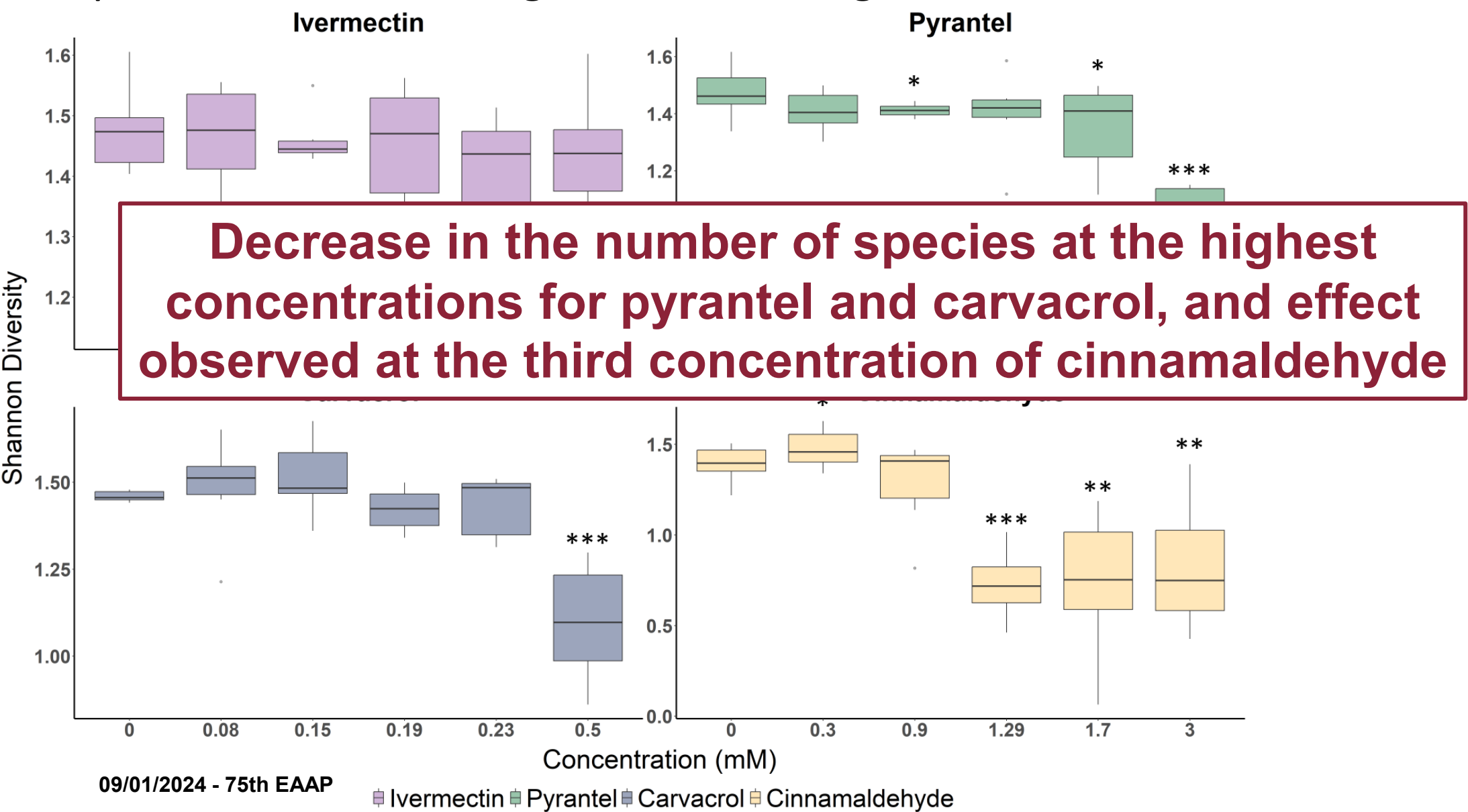
Results

Species composition structure in the control condition (0 mM)



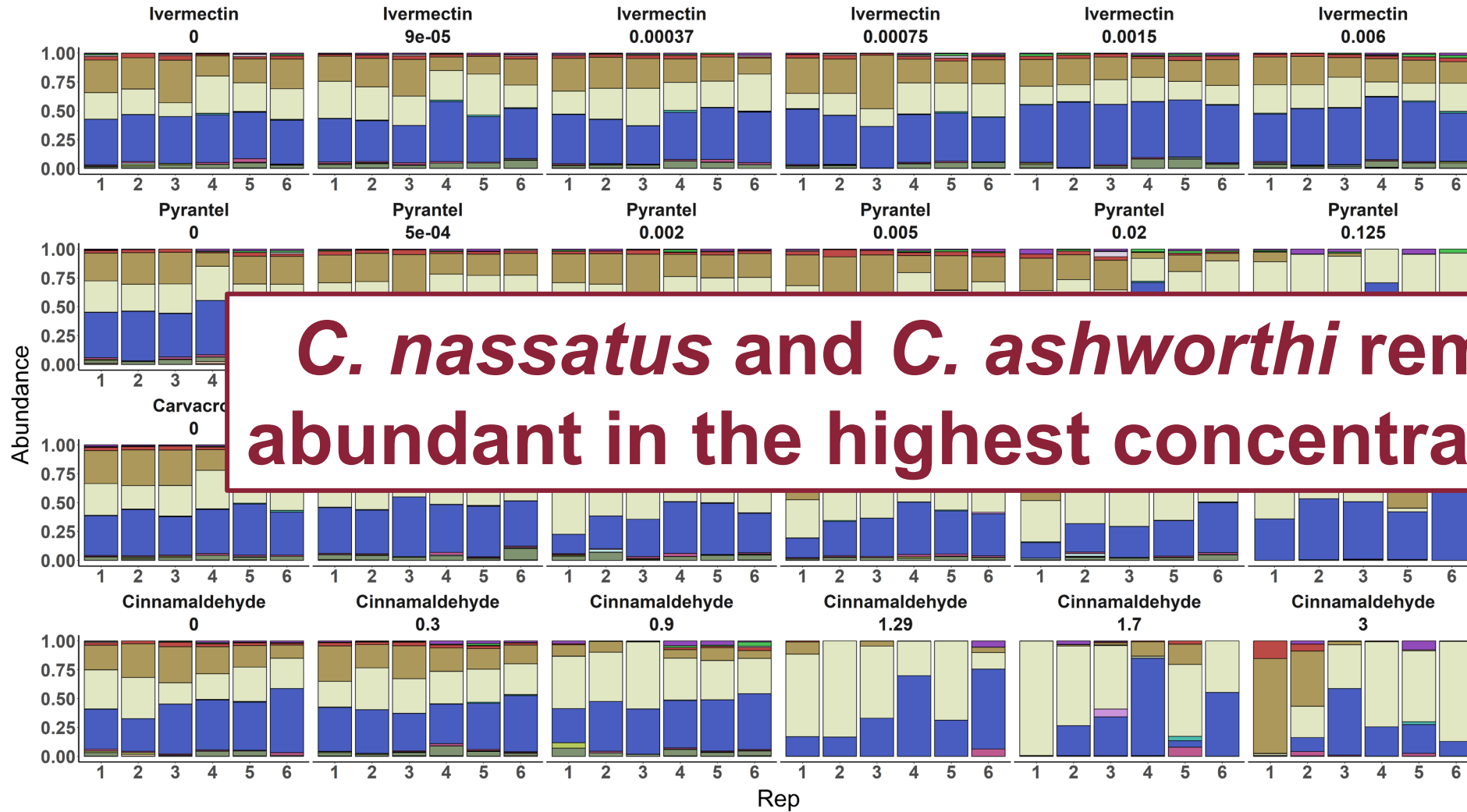
Results

Specific richness during concentration gradient



Results

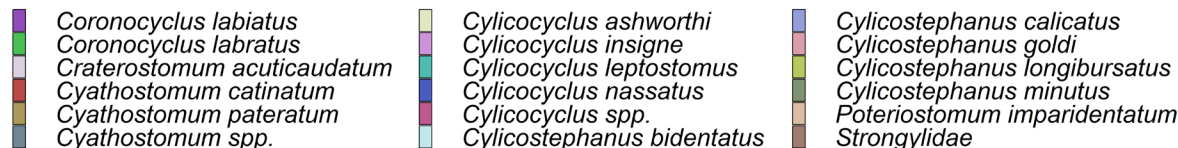
Relative abundance of species across the concentration gradient



No modification of species composition with ivermectin!

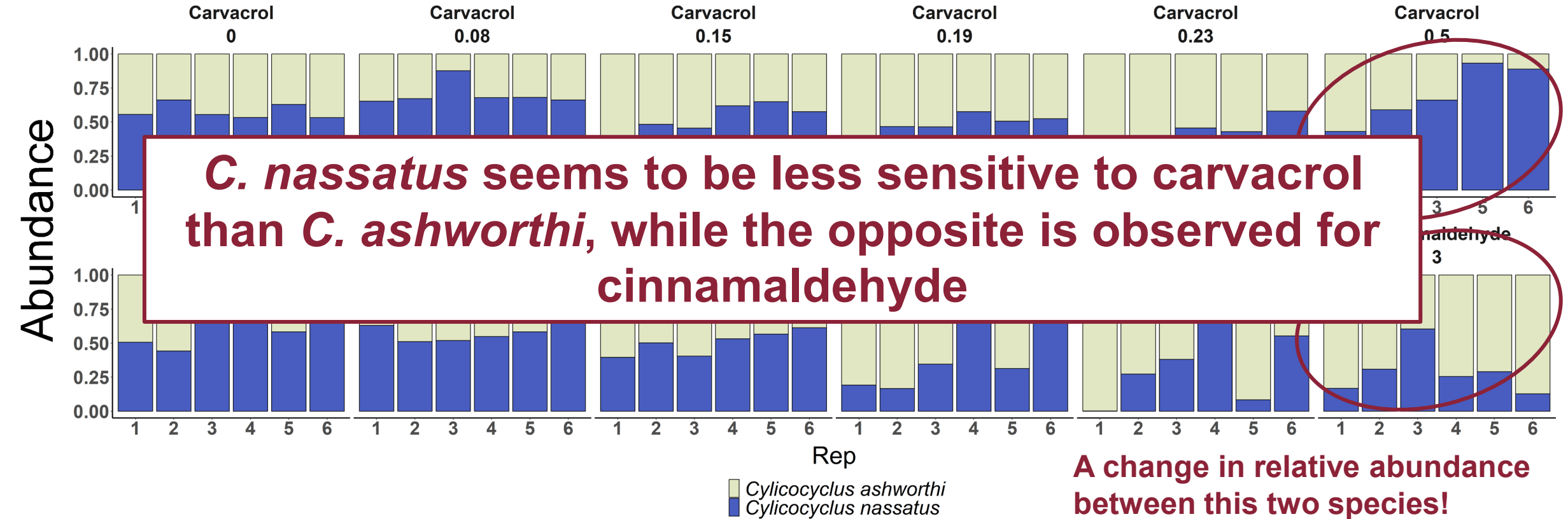
highest concentrations of pyrantel start to alter community's structure!

The structure of the community starts to change from the third concentration of cinnamaldehyde!



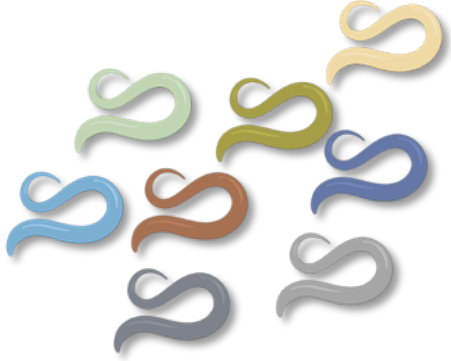
Results

Core cyathostomins species estimated (detection threshold of 0.1% and a prevalence threshold of 95%)



Conclusion & perspectives

Community behavior



- Presence of four dominant species in the control condition (*Cyathostomum catinatum*, *Cyathostomum pateratum*, *Cylicocyclus ashworthi* and *Cylicocyclus nassatus*)
- Two of these four species remain strongly present at the highest concentrations
- *C. ashworthi* and *C. nassatus* are inversely sensitive to carvacrol or cinnamaldehyde.



These results highlight the risk of selecting less sensitive species when using plant-based extracts.

This might also be the case when using plant-based treatments or supplements.



The use of plant combinations to target different species!!



INRAE



Thank you for your attention!