

Investigations on ecology and behaviour of the invasive *Halyomorpha halys* (Heteroptera: Pentatomidae) aimed at its sustainable management in agro- ecosystems

Doctorate in Agri-Food Science, Technologies and Bio-Technologies
XXXIII cycle
III° year

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Halyomorpha halys



Halyomorpha halys

Native to East Asia

Polyphagous species (>300 host plants)

Multivoltine (2-3 generations/year)

5 nymphal stages



1° instar nymph (N1)



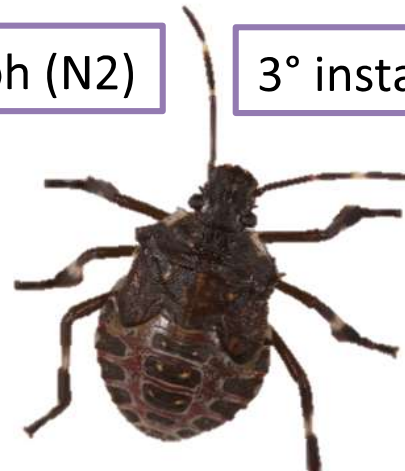
2° instar nymph (N2)



3° instar nymph (N3)

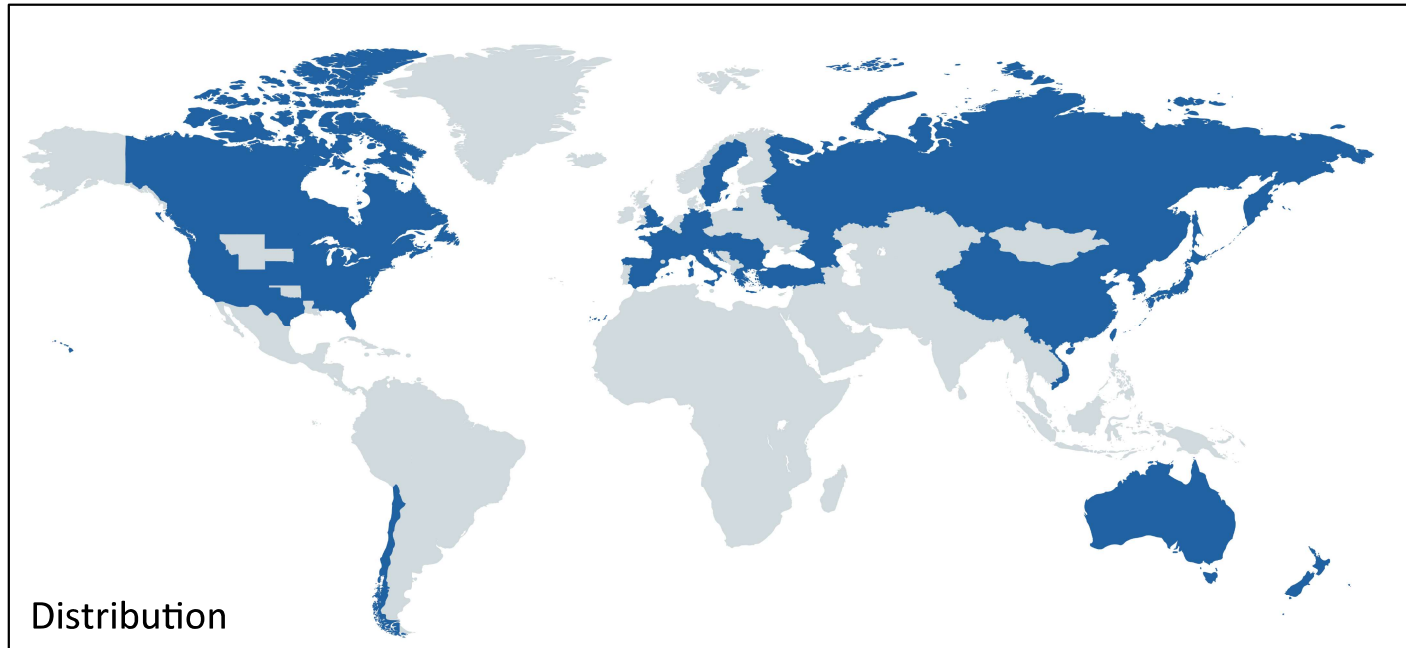


4° instar nymph (N4)



5° instar nymph (N5)

Halyomorpha halys



Direct damages



Malformations



Suberification



Discoloration

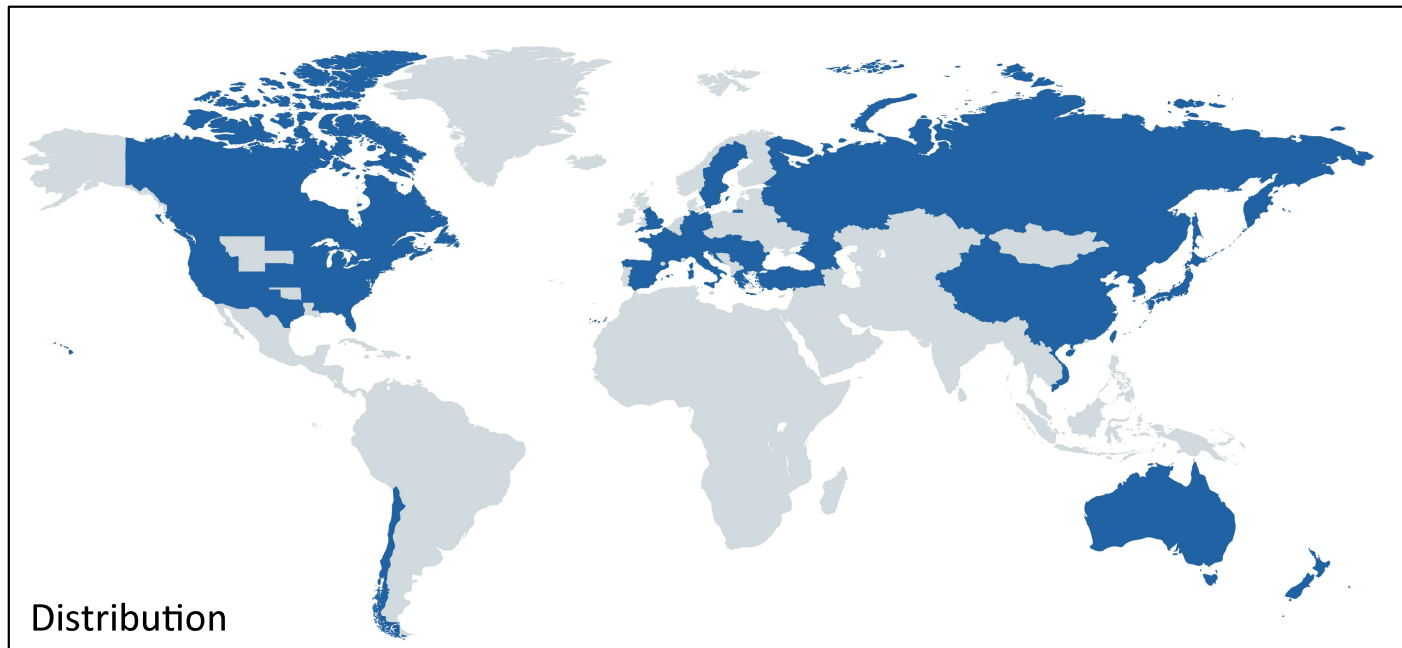


Necrotic areas



Watery rot

Halyomorpha halys



Economic damages

Over \$ 37 million for the apple trade in the U.S.A. in 2010
588 milion € in fruit production in northern Italy in 2019

Aim

Absence of fully effective techniques
Farmers increased the use of broad spectrum insecticides,
causing ecological damages

The project is focused on the sustainable management of *H. halys*, and it is divided in two main sections

Section 1: Predators

- Predatory test with solitary predators on eggs and the first two instars of *H. halys*
- Predatory test with social insects on eggs and all the instars of *H. halys*
- Gut analysis of generalist predators
- Study of the attraction of the predatory *Phidippus audax* to the aggregation pheromone of *H. halys*

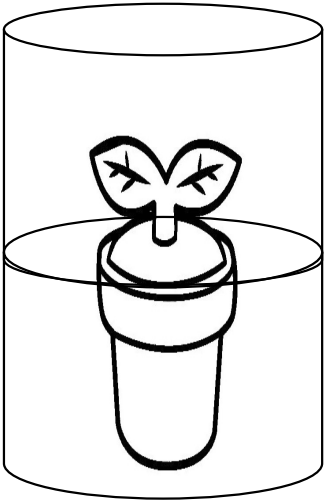
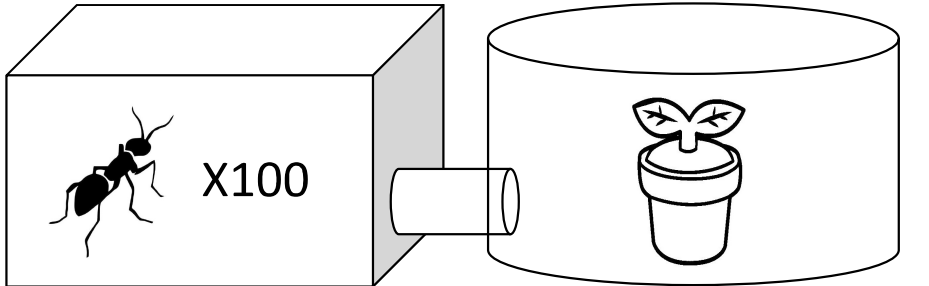
Section 2: Repellents

Repellency of essential oils at different concentrations and physiological phases
in comparison with the attractiveness of the food

Section 1: Predatory test

Solitary predators

Social insects: ants

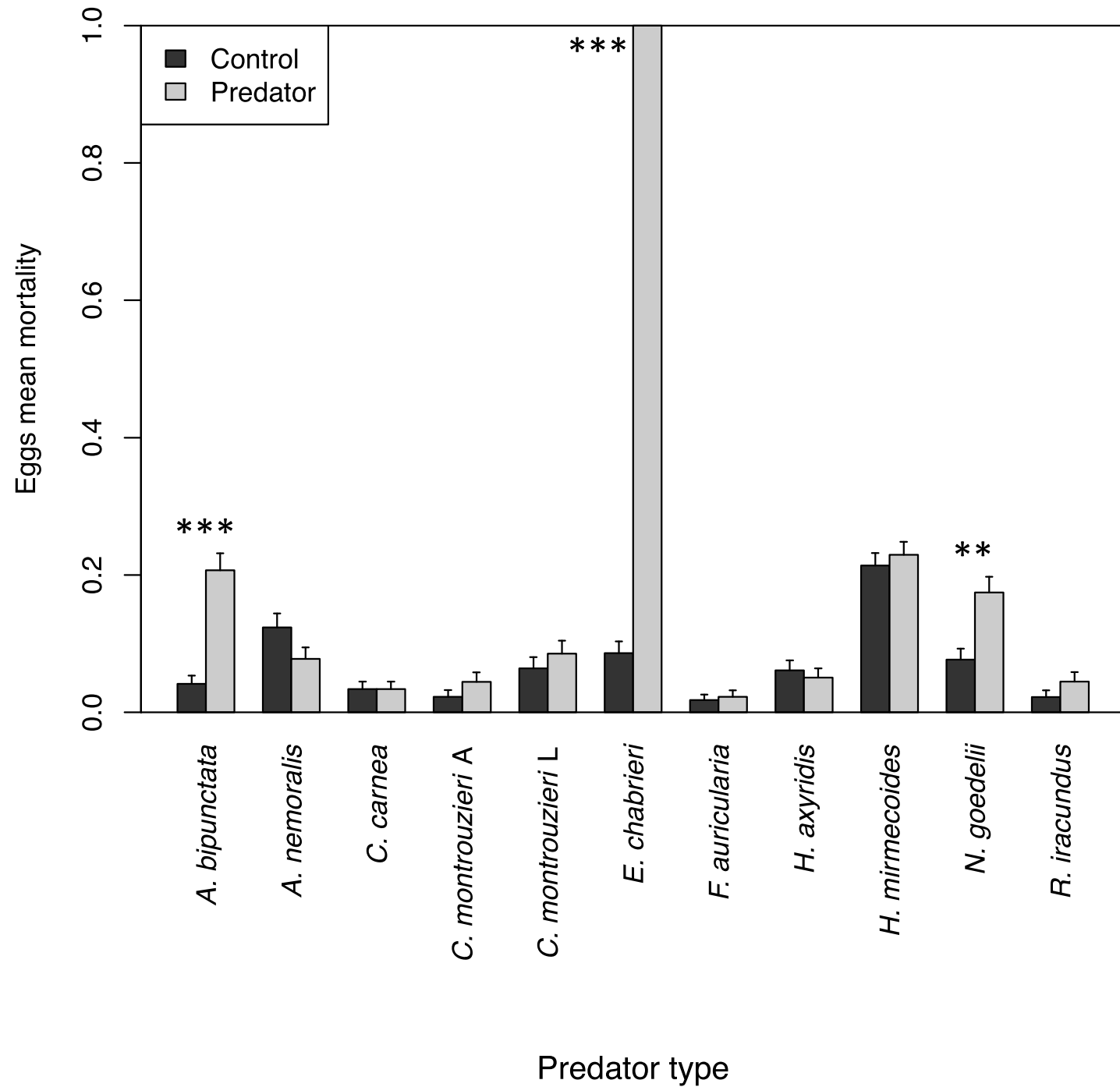
Experimental apparatus		 Nest arenaExperimental arena
Protocol	Prey: Eggs, N1, N2 24h of starvation Insertion in the apparatus Prey on the plant End after 48h	Prey: Eggs, N1, N2, N3, N4, N5 24h of starvation Access to the sperimental arena Prey on the plant End after 48h

Section 1: Predatory test

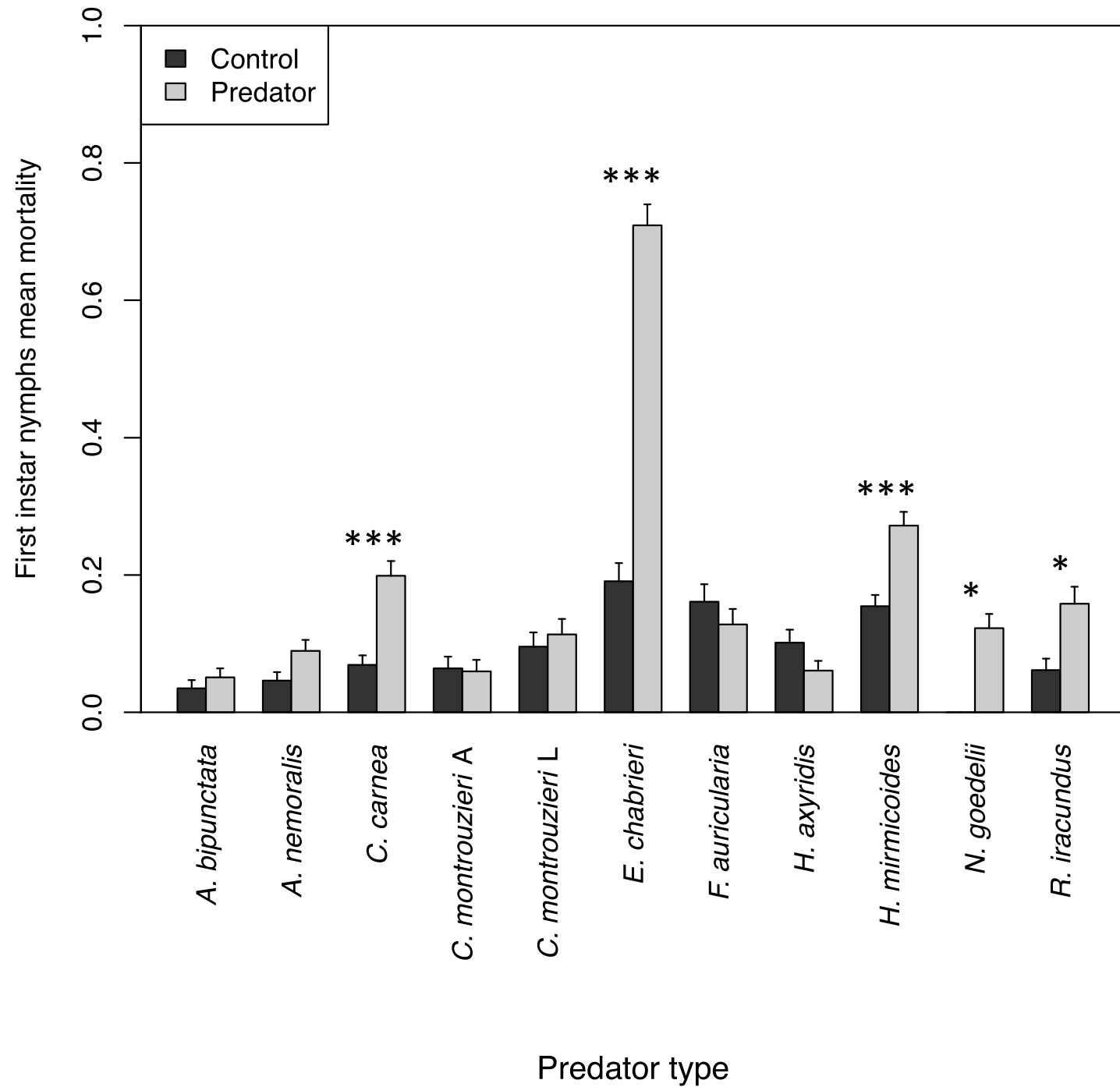
GOAL

See if native predators (social and solitary) can prey
eggs and juvenile stages of *H. halys*

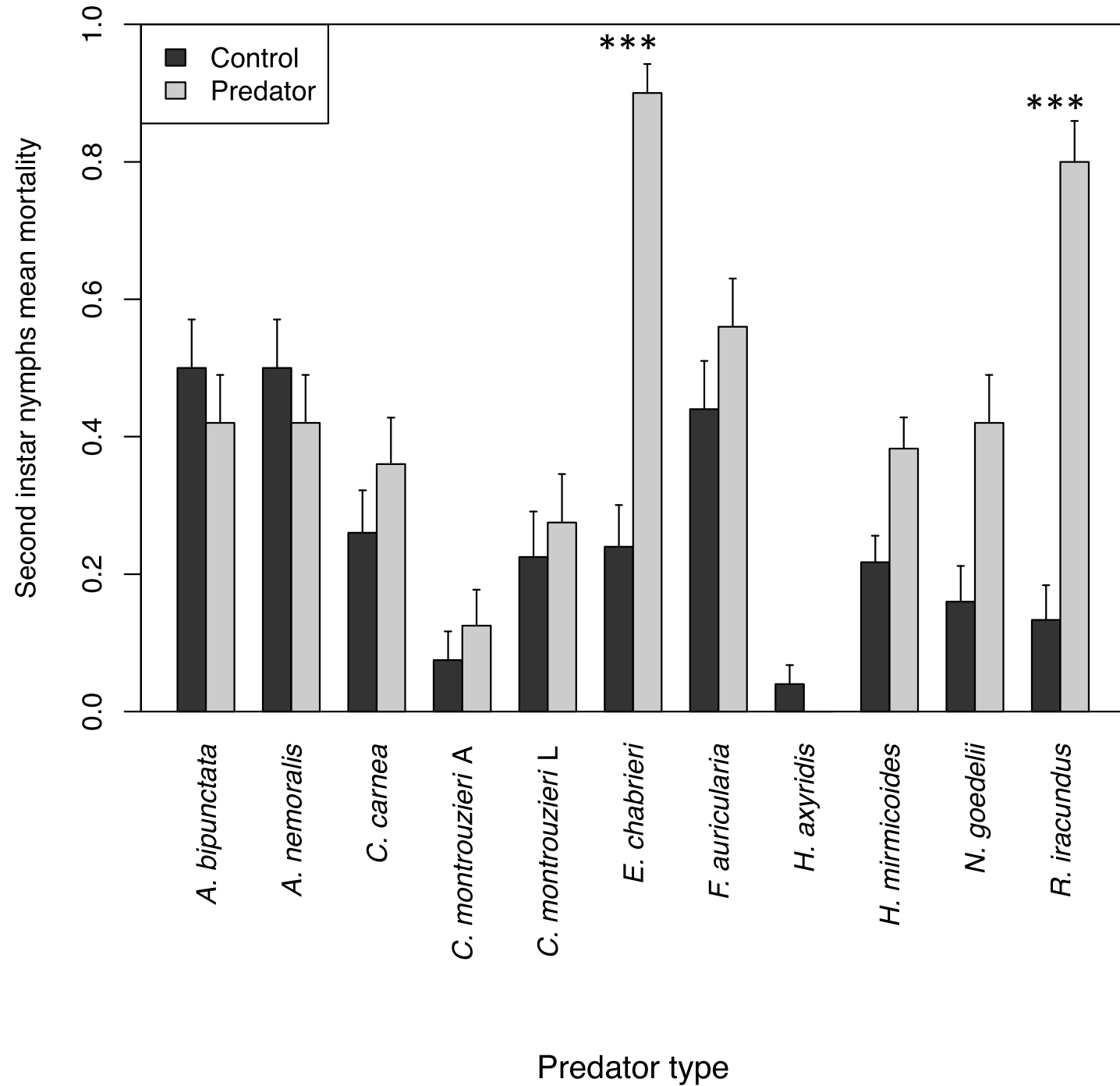
Section 1: Predatory test



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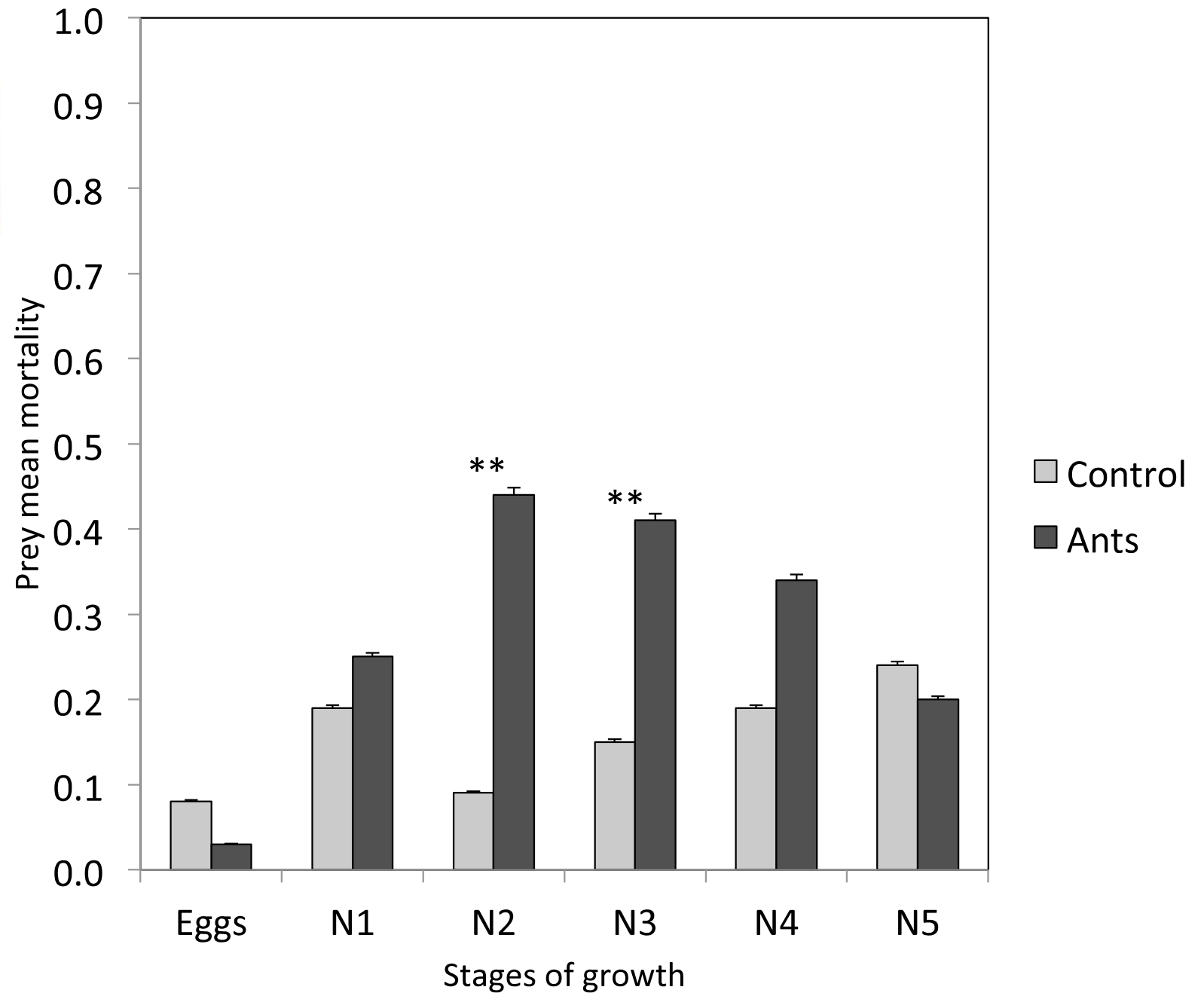
Section 1: Predatory test



Section 1: Predatory test



Lasius niger



Section 1: Gut content analysis

Predators sampling



Tree beating

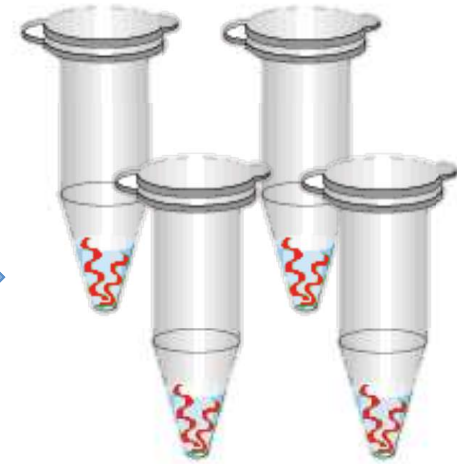


Sweep net



Section 1: Gut content analysis

DNA extraction



190 samples

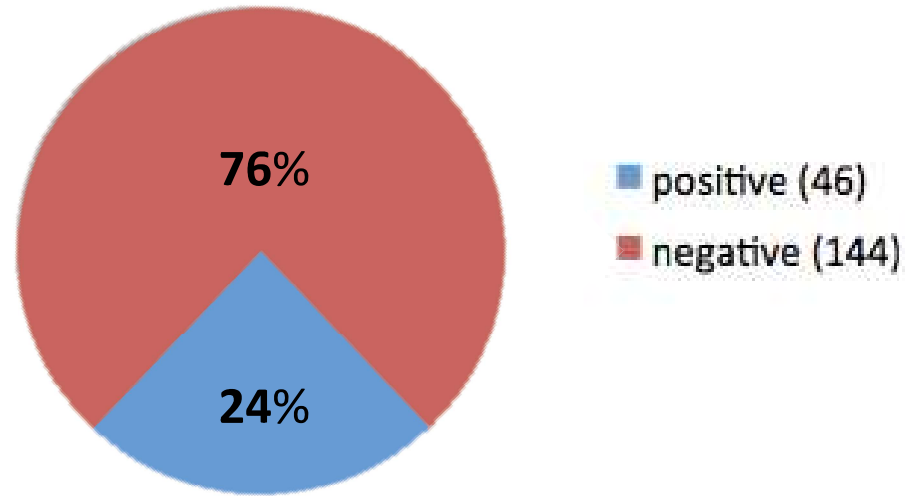


Real Time PCR

GOAL

See if in nature predators that can prey on *H. halys* are present

Section 1: Gut content analysis



4 Orthoptera



Yersinella raymondi



Phaneroptera falcata



Arachnocephalus vestitus



Tylopsis liliifolia

4 Spiders genera



Philodromus sp.



Araneus sp.



Calositticus sp.



Anyphaena sp.

3 Coccinellidae



Harmonia axyridis



Oenopia conglobata



Hippodamia variegata

2 Opiliones



Mitopus morio



Opilio canestrinii

1 Dermaptera



Forficula auricularia

1 Reduviidae



Nagusta goedelii

1 Nabidae



Himacerus mirmicoides

Section 1: Preference test



Phidippus audax

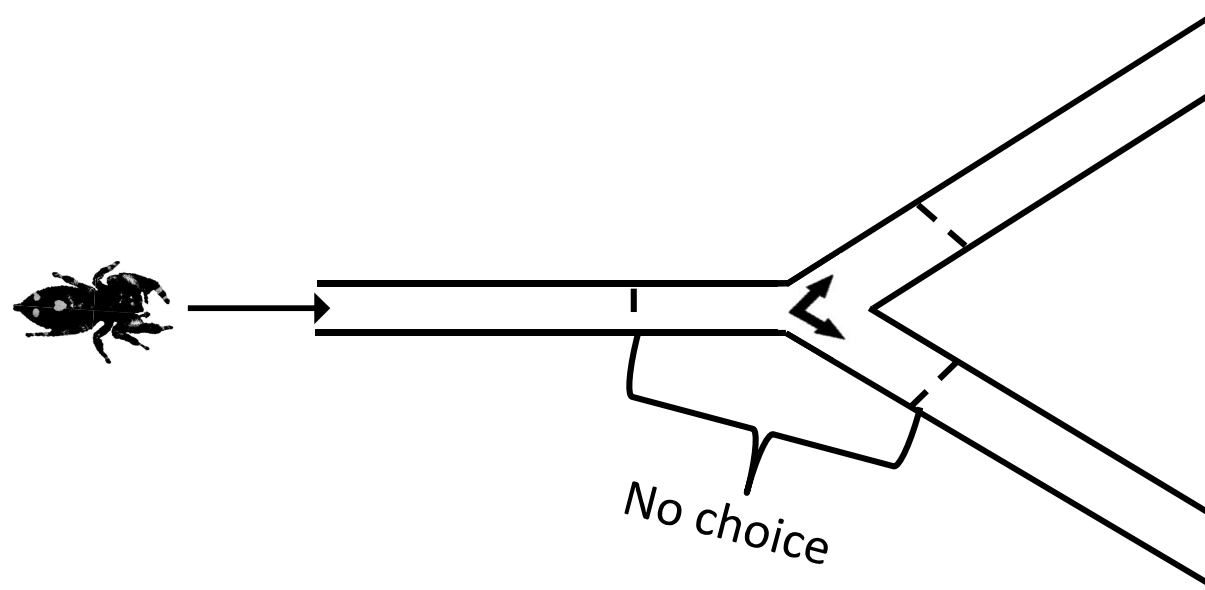
48h of fasting
Inserted in the olfactometer
Observed for 10 minutes

Pheromone combo



Pheromone 1 Pheromone 2

P460-combo della Chemtica Internacional. S.A.



Summer vs Autumn

Pure Air
Vs
Pure Air

Pheromone combo
Vs
Pure Air

Pheromone 1
Vs
Pure Air

Pheromone 2
Vs
Pure Air

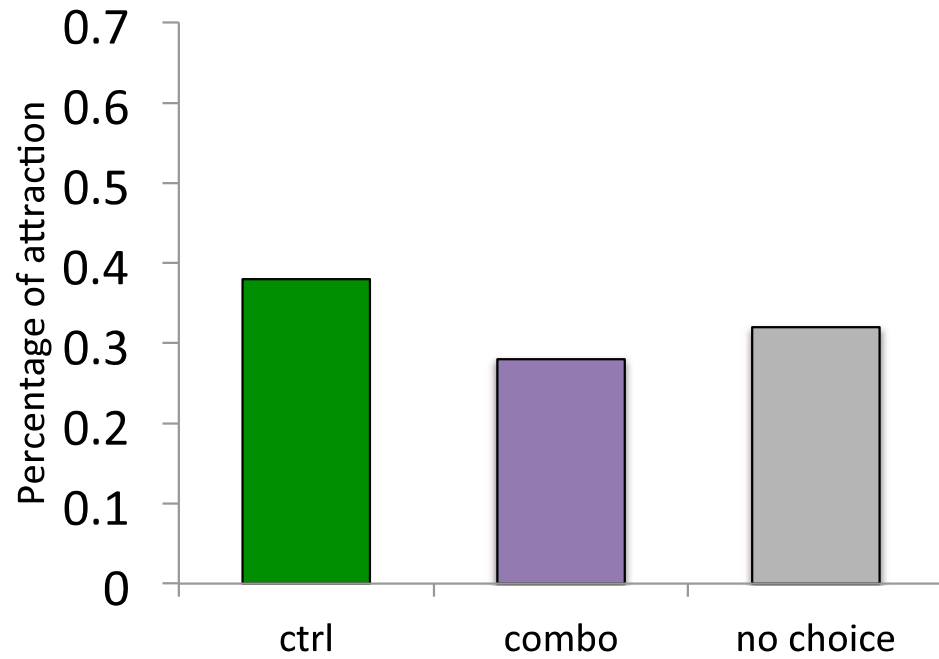
Pheromone 1
Vs
Pheromone 2

GOAL

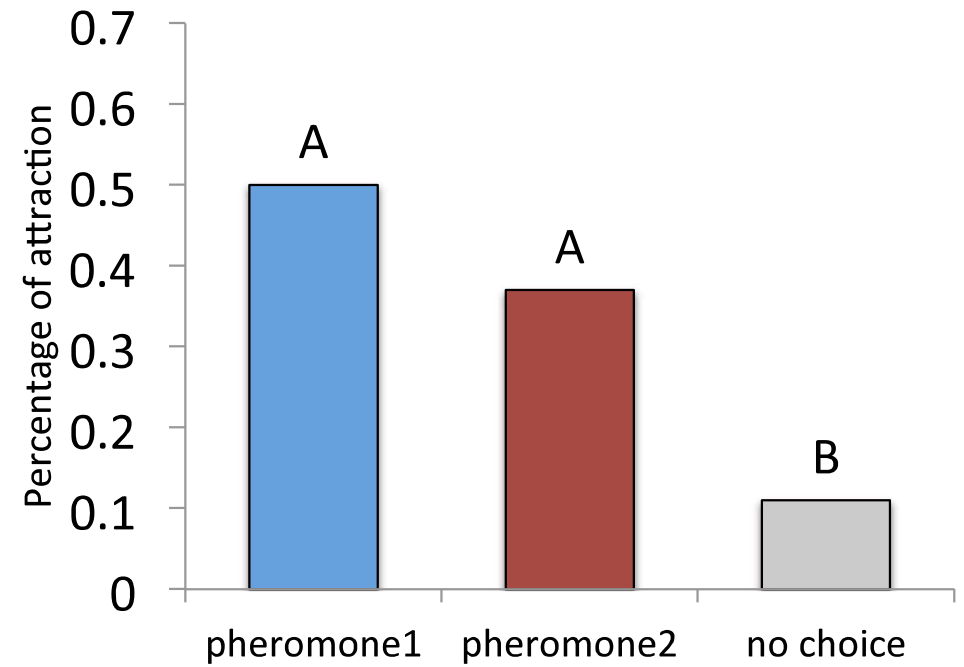
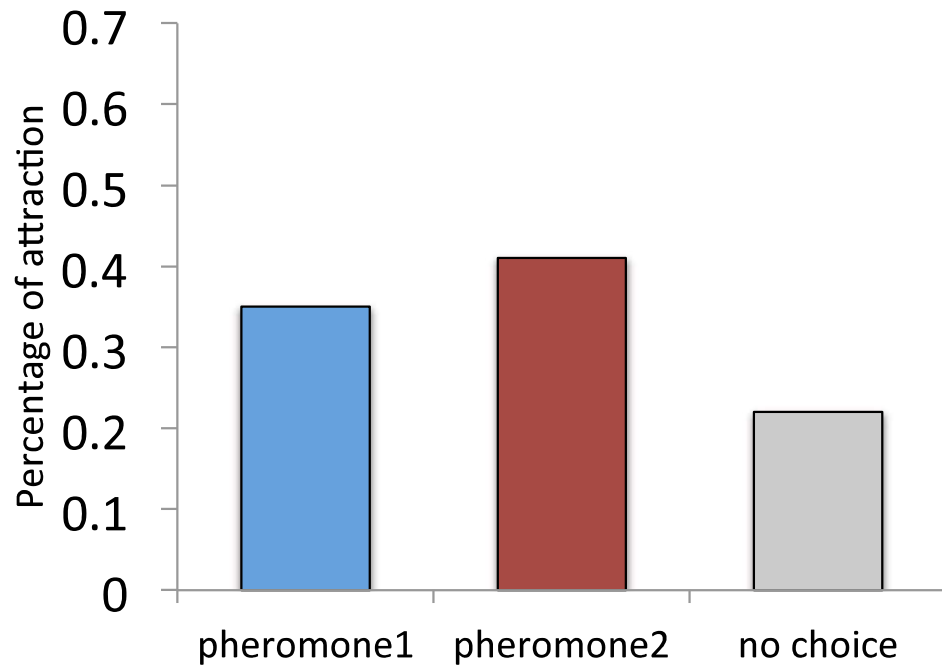
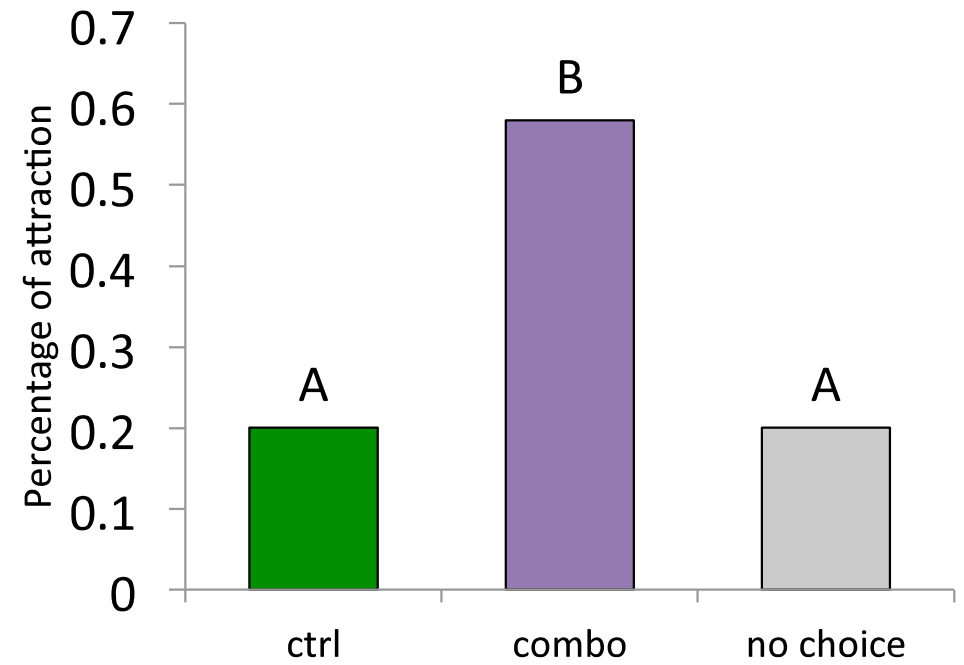
See if *P. audax* is attracted by the *H. halys* aggregation pheromone
if its attraction differ between the two seasons

Section 1: Preference test

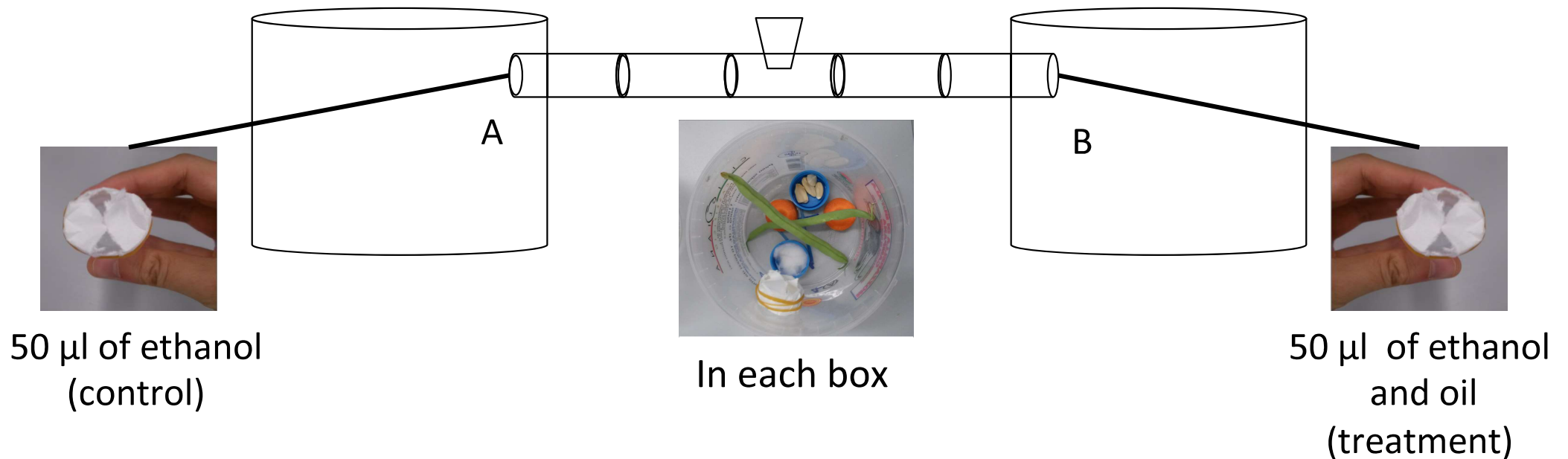
Summer



Autumn



Section 2: Essential oils repellency test



4
essential oils

×

3
physiological phases

×

6
concentrations

Ginger
Clove
Vetiver
Turmeric

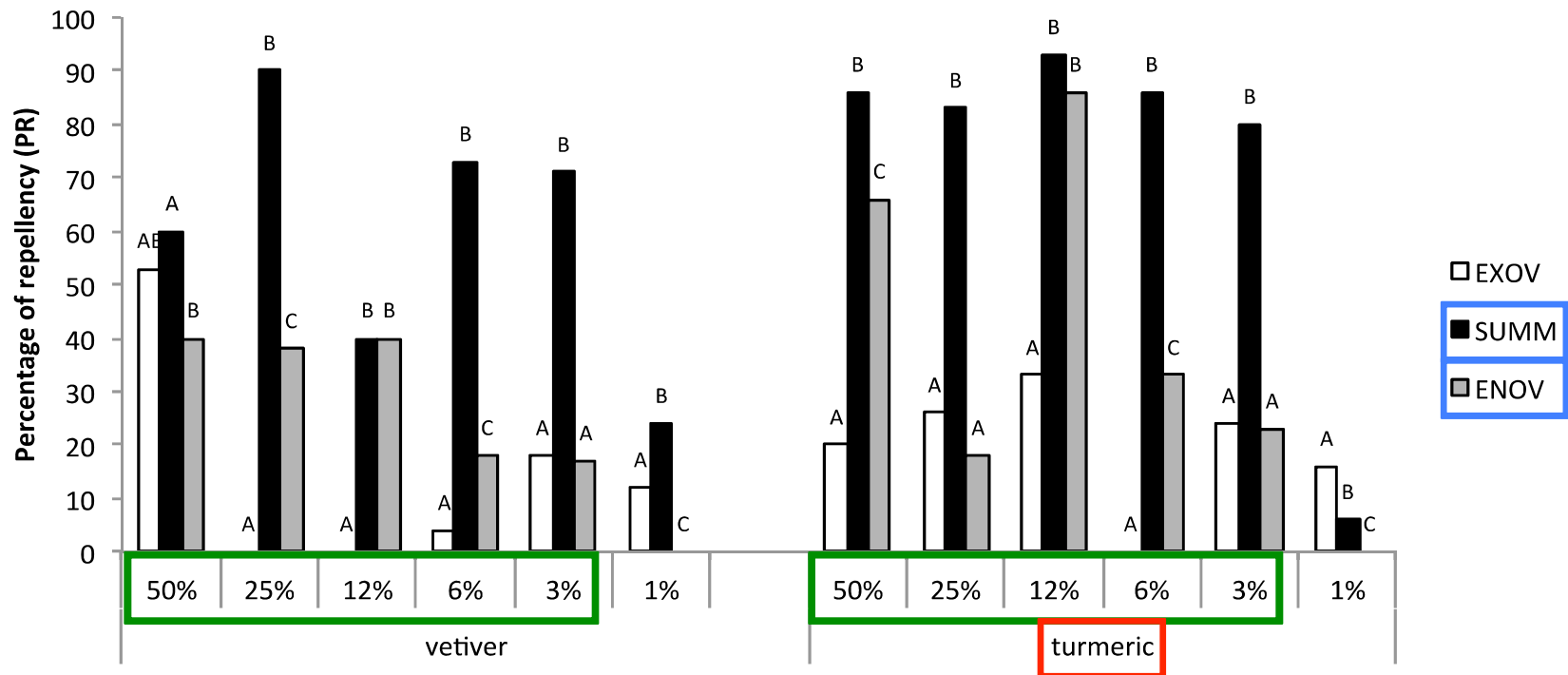
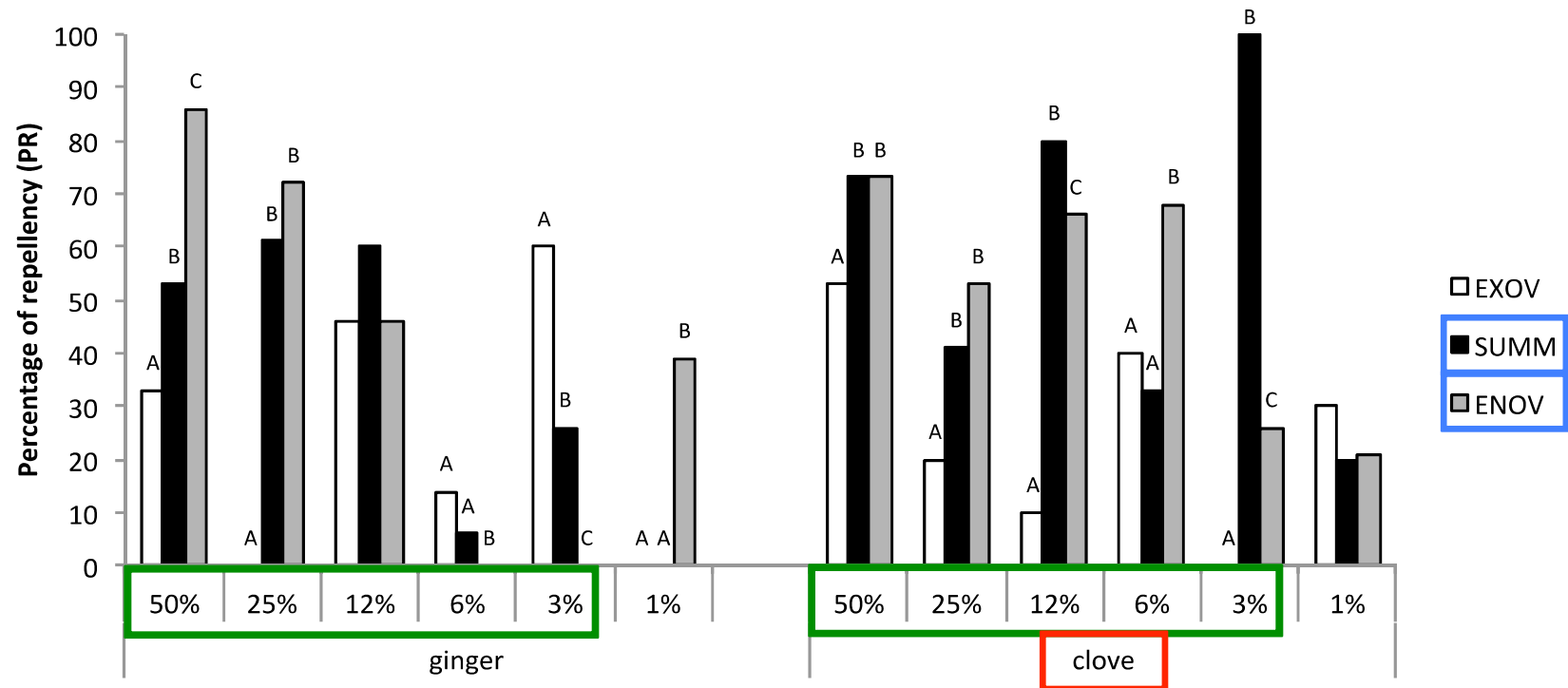
Exiting from overwintering (EXOV)
Active in summer (SUMM)
Enetring in overwintering (ENOV)

50%
25%
12%
6%
3%
1%

GOAL

If essential oils can repel *H. halys*, which one is the more effective and at which concentration
There is a physiological phase where *H. halys* is more sensible

Section 2: Essential oils repellency test



Conclusions

Generalist predators

In the Italian ecosystems possible predators are already present

Generalist native predators showed a good predatory ability on the first two instars of *H. halys*

The orthoptera showed the better results

Phidippus audax is attracted to *H. halys* aggregation pheromone in fall
It can use the pheromone as a trace to detect potential prey

Repellency test

Clove and turmeric EOs are promising repellents
In summer and in autumn *H. halys* is more sensitive to repellents



*Thank you
for your attention*